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Mapping expectations on writing and communication in engineering within a regional context: accounts from a Latin-American case

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Mapping expectations on writing and communication in engineering within a regional context: accounts from a Latin-American case

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in Education

by

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June 2016

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RECENT PUBLICATIONS

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Bazerman, Avila, Bork, Corrêa, Cristovão, Tapia & Narváez. (in press). "Intellectual orientations of higher education studies of writing in Latin America". Eds: Centre de Recherches sur les médiations. University of the Lorraine & the Writing Across the Curriculum Clearinghouse.

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ABSTRACT

Mapping expectations on writing and communication in engineering within a regional context: accounts from a Latin-American case

by

Elizabeth Narváez-Cardona

In Latin America, writing curriculum is primarily focused on freshman initiatives, emerging engineering writing initiatives across curriculum are recent (as of 2009), and there is limited amount of studies in writing development in higher education. Therefore, this dissertation describes local elements at stake in Latin America to define disciplinary writing and communication expectations of development in higher education as a phenomenon that goes well beyond freshman composition courses. Multiple sites of expectations of writing in engineering have been revealed through diverse data sources: 1) Publications on Latin-American writing initiatives in engineering from Spanish-Speaking countries; 2) Online news on engineering from the two oldest newspapers in a developing country, Colombia; and, 3) A case study within the context of a Colombian major in Industrial Engineering examined through: a) Syllabi of the major and interviews with faculty members regarding accomplishing a senior thesis; b) Submitted senior thesis reports to fulfill degree requirements; and, c) A qualitative retrospective survey of writing experiences and samples of writing assignments of undergraduate students.

As a result, this dissertation is comprised of five chapters that address separately the analysis of the prior data sources. Overall this study claims that there are specific

expectations associated with the field of industrial engineering in a developing economy that did not emerge when studies or initiatives regard “engineering” as one field without contextual nuances. One of the hypothesis emerging from this study is that the size and ideological localization of the companies that are likely the contexts of professional practices might impact a) the degree of complexity of the communication practices to negotiate solutions and circulate, create, and accept genres (small companies, few stakeholders involved, less negotiation to create and accept genres and standards, which might generate more vertical and hierarchical communication), and b) the opportunity for engineering students to develop critical stances about improving entrepreneurial environments, since they might be more concerned in genre consumption and production (such as regulations and guidelines) to regulate practices under external powerful standards (which might be primarily mandated by developed economies).

Furthermore, this study confirms that within the Engineering field in general, and in Industrial Engineering in particular, writing and communication rely on verbal and non-verbal practices that embrace different functions, which in turn imply several developmental paths that might or not might overlap, such as: a) Writing for learning disciplinary and professional concepts; b) Writing for research-oriented practices; c) Writing for commercial research-oriented practices; d) Writing for business-oriented practices; and, e) Writing for conducting and accomplishing a senior thesis. This study ultimately confirms that there is no way to assess writing development in higher education through only one source of data, since there are diverse paths configured by all of the stakeholders involved (government, writing specialists, faculty members of disciplines, students, and practitioners of the fields), which means that *development is multifaceted*.

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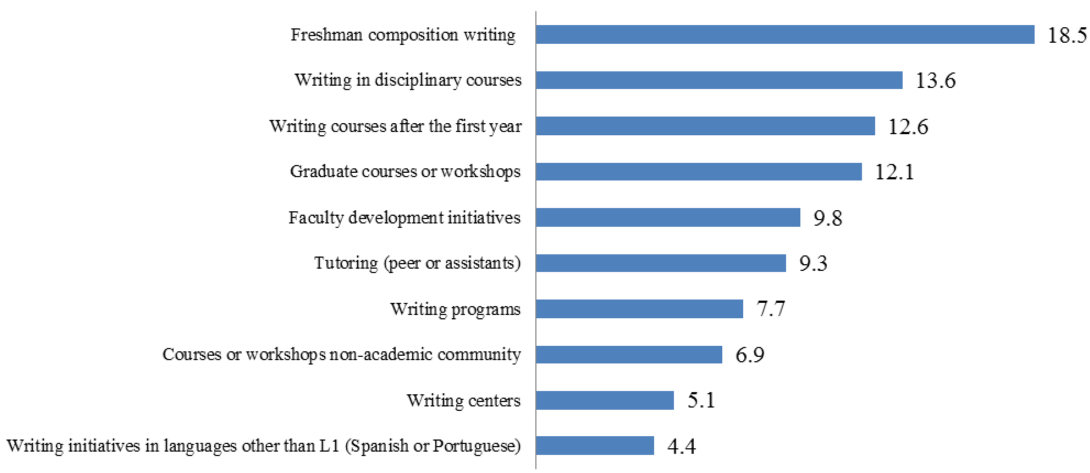
Research problem

Mapping expectations on writing and communication in engineering within a regional context: accounts from a Latin-American case

In the Colombian case, writing development in college might be characterized as an immersion process (Beaufort, 1999) or enculturation (Carrasco, Kent & Keranen, 2012) past the first year course rather than being instructed by planned advanced sequential writing experiences offered through writing programs or other similar initiatives after freshman years. This situation is similar to that in most Latin American countries (figure 1) according to the data collected in the study titled "Writing initiatives in higher education, ILEES Latin America" (http://english.ilees.org/)[1].

Figure 1
Distribution of writing initiatives in Latin American countries



As part of accreditation, The Colombian Institute for the Progress of Higher Education (*ICFES*) has mandated since 2009 a large-scale exit assessment for senior undergraduate students. Since this writing assessment is applied under the assumption that writing is a competence that still undergoes development during college years, this public policy is an opportunity for scholars of Writing Studies to conduct research for examining disciplinary writing development in higher education and adding empirical data that empower scholars for further participation in public debates about Higher Education Writing and Assessment.

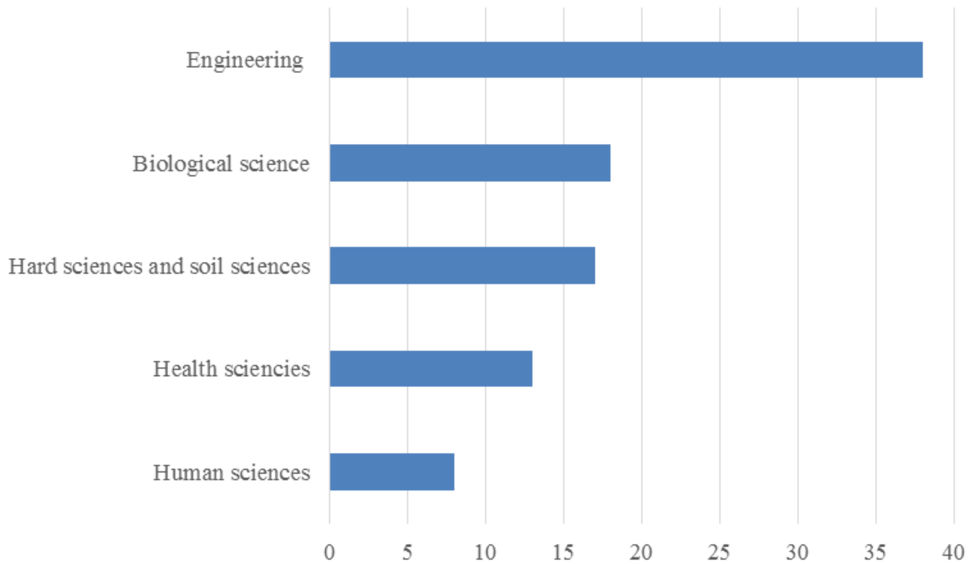
A preliminary exploration of research topics in recent Latin-American publications (2008-2012) reported by survey participants in the ILEES project suggests that studies on writing development are scarce. Only 14% of publications (4 out of 29 articles and oral presentations reported by the participants) are focused on students' changes as writers, and those are limited to questions about the impact of freshman composition courses (Flórez et al., 2010, 2011) or learning changes associated with systematic interventions for learning disciplinary concepts through writing (López & Ramírez, 2012; Arciniegas & Lopez, 2012). This does not tell us about how students' disciplinary writing develops in more advanced courses.

Furthermore, The Colombian Department of Science, Technology and Innovation (*Colciencias*) has mandated since 2010 an aggressive funding agenda to support PhD education nationally and internationally (900 students approximately are funded every year). An official report published by the Government in 2010 suggests that Engineering is the most frequent disciplinary affiliation (among others such as biological science, hard sciences, soil sciences, health sciences, and human sciences) of the PhD students who have been granted

[1] This project has collected information from 389 initiatives reported voluntarily by an online survey applied between summer 2012 and fall 2013 to scholars from Argentina, Brazil, Chile, Colombia, Mexico, Puerto Rico, and Venezuela.

with scholarships (figure 2)[2].

Figure 2
Distribution of disciplinary affiliations of the PhD Colombian students funded in 2010



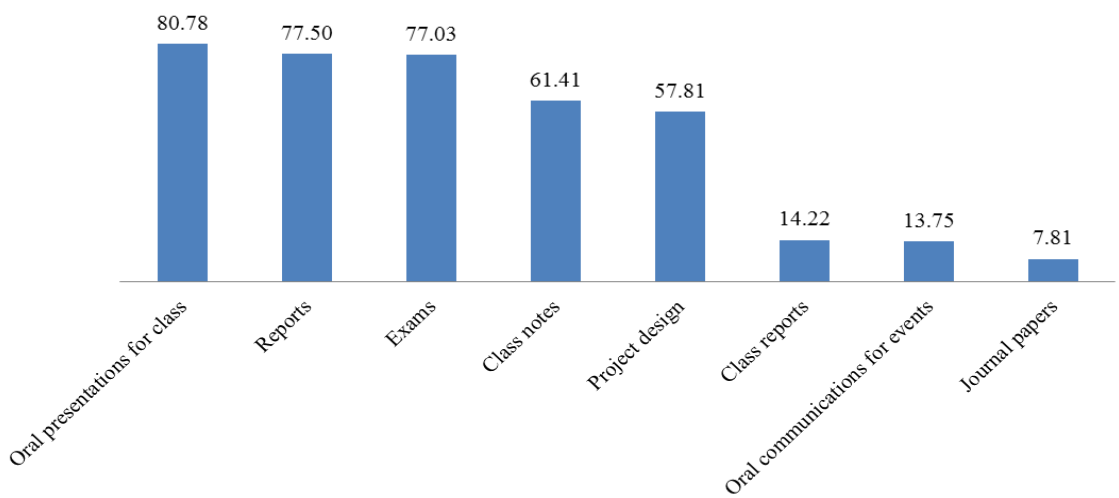
This Colombian disciplinary distribution of doctoral education overseas suggests that exploring writing development in engineering is an important research site in the region. Moreover, this research could be useful for the development of Technical Communication Programs.

A Colombian study conducted between 2009 and 2011 has already started describing reading and writing practices of junior and senior students in different disciplines across 17 universities. Figure 3 summarizes the genre distribution of types of writing assignments reported by the survey participants in engineering, which shows that writing is primarily associated with classroom activities and genres such as oral presentations for class, reports, exams, class reports, and class notes, but there are a few types of writing that go beyond the classroom (project design, oral communications, and journal papers) (Rincón, Pérez-Abril et

[2] This information is available at: *Colciencias selecciona la "Generación del Bicentenario"* (2010). Retrieved

al., 2013). In this respect, this is not so different from what has been found by researchers in North America (Dias & Paré, 2000; Beaufort, 2007).

Figure 3
Genre distribution of what Colombian junior and senior undergraduates reported that they write in Engineering



However, there have been endeavors since 2009 to address writing studies and initiatives in engineering after freshman composition courses, as indicated by a preliminary exploration of titles and introduction sections of papers written by Latin American scholars[3].

Within this context (i.e., writing curriculum primarily focused on freshman initiatives, emerging engineering writing initiatives across curriculum, and limited amount of studies in writing development in higher education), research is needed to identify local elements at stake in Latin America to define disciplinary writing and communication variation and development in higher education as a phenomenon that goes well beyond freshman composition courses. Additionally, this study contributes to the International field of Writing

December 5, 2015, from http://www.colciencias.gov.co/noticias/colciencias-selecciona-la-generaci-n-del-bicentenario

Studies, especially to the U.S. field of Technical Communication, by examining the role of technical writing in educational systems of countries with different economies.

Accordingly, this dissertation aims at determining: *What might be the expectations on writing and communication in an engineering undergraduate program of a Latin-American university?*

Since this study acknowledges the theoretical and empirical complexity of creating accounts about writing expectations in disciplines, this project unpacks multiple sites of expectations on engineering writing and communication:

1. Publications on Latin-American writing initiatives in engineering from Spanish-Speaking countries.
2. Online news on engineering from the two oldest newspapers in a developing country, Colombia.
3. A case study within the context of a Colombian major in Industrial Engineering examined through:
    a. Syllabi of the major and interviews with faculty members regarding accomplishing a senior thesis.
    b. Submitted senior thesis reports to fulfill degree requirements.
    c. A qualitative retrospective survey of writing experiences and samples of writing assignments of undergraduate engineering students.

As a result, this dissertation is comprised of five chapters that address separately the analysis of the prior data sources.

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[3] As I explain in chapter 1, a comprehensive sample of publications was created based on my professional connections in the Region, since there is no a central venue to easily access to literature on writing studies and disciplines in Latin America.

In the Latin American case, there is no specific field equivalent to Technical Communication as developed in the U.S.; however, there is a body of emerging Latin-American writing initiatives and studies in engineering. Therefore, the first chapter analyzes Latin-American publications from Spanish-Speaking countries to map programs pursued in the Region and then provide a context to envision further research agendas for Latin-American Writing Studies in engineering.

Since Technical Communication is an interdisciplinary field established in the context of a developed economy, the second chapter reviews literature on technological innovation and economic growth in Latin America and chronologically analyzes online news on national engineering from the two oldest newspapers in a developing country, Colombia, with special attention to implications on learning writing, language, and communication. Such context is discussed within a literature review of the U.S. scholarship on Technical Communication to propose research agendas for a Latin-American country.

The first chapter reveals, among other issues, that Latin-American initiatives and studies in engineering writing and communication of Spanish-Speaking countries are emerging, focused on engineering as one field, and it is not frequent to consider writing/language as a multimodal phenomenon. Therefore, the third chapter offers insights that might inform writing curriculum design in a specific engineering subfield, Industrial Engineering, by including expectations of verbal and non-verbal writing (e.g., graphics, tables, or pics) and communication over time.

Two types of data have been analyzed: a) Faculty members’ expectations regarding conducting and writing a senior thesis, since this is the most ambitious writing project students need to address in this undergraduate curriculum; and, b) Disciplinary learning expectations of ways of doing and thinking with special attention to writing and communication including non-verbal expectations that are stated by the instructors through syllabi.

Preliminary data collected in fall 2013 through interviews with faculty members of the very same Colombian undergraduate program in industrial engineering examined in chapter three confirms that a senior thesis in this major is a written genre utilized to assess academic and professional growth from students through verbal and non-verbal systems. Faculty members also pointed out specific institutional constraints that might aggravate conducting and writing a senior thesis: a) the lack of negotiation among faculty regarding linguistic and non-linguistic contents expected from the reports; and, b) time limitations to guide and evaluate the projects. Therefore, the fourth chapter describes academic and professional writing growth expected from the students as novice practitioners in conducting a senior thesis by creating accounts of types of academic and professional practices related to genre production that might have been used by senior students in accomplishing their senior theses in Industrial Engineering.

The analysis of the syllabi in chapter three suggests that there is no overt pattern across semesters regarding specific growth or changes across time for different types of writing and communication practices to learn and become practitioner of a major in Industrial Engineering. Therefore, this final chapter creates accounts of disciplinary writing variation by curriculum years from the students' perspective through exploring retrospective accounts of writing experiences and analyzing writing assignments[4].

The conclusion section responds the research question: "*What might be the expectations on writing and communication in an engineering undergraduate program of a*

[4] Since the data has been collected in Spanish, the chapters provide fragments of the cases to illustrate the evidence of the analysis by incorporating interpretations in English. These translations were done by *Ingrid*

Latin-American university?", and also offers insights regarding the following questions pertaining to the field of Writing Studies:

1. *What counts as "development of writing and communication" in a specific area of engineering: a Colombian major in industrial engineering?*
2. *How does this study inform Latin-American writing curriculum and teaching initiatives in engineering?*
3. *What does this study from a developmental perspective contribute to genre studies in disciplines?*
4. *What does this study inform about teaching and assessing writing from a developmental point of view?*

Julieth Hernández Cuero, senior student of the Degree in Foreign Languages of the *Universidad del Valle* in Colombia.

I. Chapter 1. Latin-American writing initiatives in engineering from Spanish-speaking countries

Abstract

In the Latin American case, there is no specific field equivalent to Technical Communication as developed in the U.S., which is an interdisciplinary field to investigate and teach about production and circulation of scientific and engineering contents; however, there is a body of emerging Latin-American writing initiatives and studies in engineering. This chapter analyzes Latin-American publications from Spanish Speaking countries to map programs pursued in the Region and then provide a context to envision further research agendas for Latin-American Writing Studies in engineering. The analysis of titles, abstracts, and sections of conclusions and discussion of a convenience sample of 22 publications was conducted. The data suggests that since 2009 writing initiatives and studies on engineering writing and communication in Latin America have been undertaken. The sample reveals an emphasis on pedagogically-oriented publications that have had institutional supports or exigencies (i.e., departmental supports, curriculum reforms, or faculty development programs). The tendency of the initiatives/studies has been focused on engineering as one field, which suggests the need of further studies in exploring disciplinary features of writing and communication by subfields in engineering (e.g., mechanical engineering, biomedical engineering, industrial engineering). Furthermore, the trends of the analysis reveals that the Latin-American writing advocates in engineering might benefit by incorporating theoretical frameworks for a) exploring and understanding different roles of writing across time and curriculum in student learning and by engineering subfields and, b) exploring theoretical approaches to understand genres beyond individual texts (i.e., genre repertoires and genre systems).

A. Introduction

The interdisciplinary field of Technical Communication has developed in the U.S. as part of historical and evolutionary interactions among economic changes, scientific developments, and digital technology innovations. The field has been fostered especially by the advancements of disciplines such as engineering which generates both scientific knowledge and financial profit. This interdisciplinary field has emerged to research and teach communication practices within institutions (companies, research centers, civil organizations, government, and universities) associated with scientific and technological changes and corporate capitalism in North America; however, these conditions may not match those in Latin America.

In the Latin American case, there is no a specific field equivalent to Technical Communication as developed in the U.S.; however, there is a body of emerging Latin-American writing initiatives and studies in engineering. Therefore, this chapter aims at exploring features of Latin-American writing initiatives in engineering reported by publications (journal articles and oral communications) from Spanish-Speaking countries to map programs pursued in the Region and then provide a context to envision further research agendas for Latin-American Writing Studies in engineering.

B. Technical communication programs in the U.S.: teaching and research agendas

To contextualize the North American model of technical communication, this section offers an overview of the agendas of technical communication programs in the U.S. This literature review will be used later to discuss the analysis of Latin-American publications of Spanish Speaking countries and envision further research agendas for Latin-American Writing Studies in engineering.

1. The status of the U.S. field of Technical Communication

Several studies have mapped the scope of the field of Technical Communication. Scholars aim at understanding the history, the influence of different disciplinary traditions, and tensions between theories and practices in academia and workplace settings (Selfe & Selfe, 2012). Overall, the field is acknowledged as interdisciplinary, since it shares and borrows methods, theories, and even content areas from design communication, speech communication, rhetoric and composition, psychology, education, and computer science

(Spilka, 2002; Rude, 2009). This might be related to an unformed disciplinary identity and the lack of external recognition; situation that has been attributed to multiple causes: a) the relative newness of the field as an area of inquiry; b) the assumption that the field on technical communication offers “services”, in both corporate and academic settings, to more dominant fields such as engineering, information technology, and business; and, c) the adjunct status of technical communication programs within the English departments (in which they are usually housed), and within the broad field of rhetoric and writing (Rude, 2009).

Regarding the status of the courses, universities often treat Business and Technical Communication Programs (BTC) similarly to first-year composition (FYC); this is, as a writing course that is separate from courses in other disciplines. As happens in FYC courses, BTC courses for non-majors are perceived as service courses, and their instructors must struggle for status and identity within their universities (Russell, 2007). Technical communication instructors have reported they often feel like outsiders within English departments, because faculty members specialized in literature ignore the academic status of the field when deem technical communication as service courses rather than a research area. Therefore, technical communication instructors are typically hired as lecturers rather than tenure-track positions. Sometimes instructors in writing programs are better situated in terms of status, community, and respect. However, these programs are also often considered service areas (Reave, 2004).

Diverse student population shapes the BTC programs. In technical communication courses within engineering schools, all the students are engineering majors; whereas in courses taught outside the schools, students from other majors attend. A diverse student body is more typical for elective courses (Reave, 2004).

Furthermore, “writing to learn” and “learning to write”[5] are still part of the pedagogical debates in the field, because BTC courses are seen as more disciplinary or professionally orientated than first-year composition courses (FYC), which are mainly associated with general education classes[6]. BTC research and pedagogy have mainly focused on workplace communication and on preparing students for workplace communicative practices (Russell, 2007). As a result, BTC courses for majors typically are comprised by a more cohesive student population in terms of their majors than those in liberal arts courses (FYC associated with general education) (Russell, 2007).

The academic unit housing the programs of technical communication is also an issue of debate mostly because of the diversity of approaches from humanities, professional, and science communication (Maylath, Grabill & Gurak, 2010). For instance, since Departments of English offer "services" to engineering majors, teaching this type of courses is seen as a goal outside of the main purpose of English departments. Therefore, technical writing instructors (and scholars) are seen as subservient to both engineering and English but essentially at home in neither place (Yeats & Thompson, 2010).

Overcoming the tensions between English departments and technical communication programs is thus seen as an important issue in the agenda of the U.S. field (Bernhardt, 2002). The tensions might be overcome insofar as it is accepted that technical writing has humanistic value by exploring rhetoric features in science communication even under

[5] Carter et al., (2007) cite Broadhead, 1999 (p. 19) to summarize these two approaches “writing to learn—i.e., writing as a means of acquiring information, understanding concepts, and appreciating significance in any discipline . . . [versus] learning to write—i.e., acquiring the socially-mediated communication skills and genre knowledge appropriate to a specific discipline” (Broadhead, 1999, p. 19).

[6] General Education is a distinctive feature of the U.S. Higher Education system that is not necessary present in other universities around the world. According to Adler-Kassner (2014), general education has been an effort within the U.S. academy to “create the dynamic tension between liberal learning, professional training, and Disciplinarity” (p. 438). In other higher education systems, core courses (many of them related to humanities, social sciences, writing in mother tongue and second language, and statistics) might count as this U.S. educational goal of seeing core education as less disciplinary-oriented.

expectations of objectivity (Miller, 2004). Cultural beliefs tend to treat “technology” and "data" as fixed and unbiased objects, but these assumptions change if science production is acknowledged as a rhetorical act, this is, knowledge production as a result of interpersonal negotiations in interpreting evidence (Winsor, 1996).

Debates over the status of the field have therefore influenced research and teaching agendas. One of the visible debates is how to define the ideal practices of the field. If technical communication and writing simply draw on the best practices carried out by industry and other workplace settings, non-academic environments would be producing authoritative knowledge, which leaves a narrow intellectual space for the discipline. Instead, if technical communication and writing are more than instrumental means predetermined by others, academic knowledge on technical communication and writing can advise about qualities of workplace practices (Monberg, 2002; Boettger, & Lam, 2013).

Furthermore, under the importance of models on “expanding learning” (Bernhardt, 2002)[7], a research agenda is needed to provide information about transitions and overlapping practices between industry and academic settings; this means that academia and workplaces should interact to boost knowledge propagation and innovation between these two contexts.

The research agenda of the field of Technical Communication must also include studies on what has been marginalized or silenced (Thralls & Blyler, 2002). One of the marginalized topics is the study of tacit system of values and commitments with bureaucratic

[7] The theories on "expanding learning" assume that individuals are change agents who participate either in crossing-concurrent contexts (i.e., courses in the same semester or university coursework and a part-time job), or sequential contexts (e.g., sequences of courses in a major, high school to college, or from a college program to a post-graduation job) (Tuomi-Gröhn & Engeström, 2003). By participating in several contexts, individuals may engage in both routinized (low-road) and transformative (high-road) forms of transfer (reutilizing knowledge learned in concurrent or sequential contexts) as they draw on and utilize prior knowledge and learning experiences (Moore, forthcoming). This model explains how transitions and knowledge propagation ensue as opportunities to overcome discontinuities and contradictions of participating in several contexts (Rounsaville, 2012), while also might provide novel ideas for regenerating status quo or traditions.

hierarchies, high technologies, and corporate capitalism that are embedded in technical communication practices (Miller, 2004). This marginalized topic is part of cultural studies in which power and contradictions are explored as ongoing and emerging forces in interaction within organizations. Therefore, under this agenda studies aim at democratizing participation of those who have been seen as historically relegated in organizations. One of the ways to do so is by conducting participatory research, which gives voice to those who are being investigated (Thralls & Blyler, 2002).

2. Technical communication and digital technologies

Studies have also documented emerging technical communication practices because of the influence of digital technologies. Developments in mobile technology have encouraged more cooperative work that is contingent and not physically-situated. On one hand, more people can work anywhere by telecommuting, collaborating electronically, and running their own business with mobile phones and laptops; however, on the other hand, freedom to work anywhere often means isolation and difficulty to build trust and relationships with others, which brings restricted opportunities for collaboration and networking but opportunities for co-working. As a result, co-working is an emerging technical communication practice that has been recontextualized by other inter-organizational activities as freelancing, virtual teams, and peer production (Spinuzzi, 2012).

Because of the influence of digital technologies in technical communication practices, some scholars have claimed that the main goal of BTC programs is to increase students' marketability to be prepared for the job market, mainly by increasing their skills for documentation process in the age of cooperative-technological interaction. Accordingly, practitioners are expected to learn problem-solving and analytical skills, writing ability, and flexibility to keep learning on new digital writing situations (Tolley & Kim, 2004; Rainey et al., 2005; Yeats & Thompson, 2010).

This is why computer literacy is visible in the pedagogical agendas. There are different types of courses: a) skill courses for every day computer literacy at workplaces; b) courses on hardware and software for technical communication practices; c) courses on desktop publishing or graphic design programs that are focused on cost-effective productions for organizations; d) publication management courses; e) computer intensive instruction in introductory writing courses; and, f) computer literacy courses to build critical awareness on digital reading and writing practices. Pedagogies on critical computer literacy particularly advocate for ideological analysis of literacy practices surrounding computer usage against to computer-skills pedagogies (Selber, 2004).

3. Subject matter of the courses: science communication, professional genres, research skills, and journal publication

Besides including digital communication practices in the curriculum, pedagogical agendas also stress the role of drawing in learning science. Students are encouraged to represent knowledge through drawing, observation, recording, and making inferences as opportunities to learn inductively on scientific concepts. Different goals are pursued: a) encouraging students to produce visual texts; b) increasing awareness of rhetorical effects of graphics and images in science (semiotic realities created by disciplinary communities) rather than groups of facts (Lerner, 2009).

There are, for instance, pedagogical experiences in which students are taught about how scientists make complex decisions in designing experiments and reporting quantitative data for creating claims while addressing their peers. These initiatives support students in understanding differences between "raw data" such as: jots, plots, notes, outputs, visual traces produced in labs and "evidence" for publications and communications (selected data) (Poe, Lerner & Craig, 2010). According to the systematizations of these experiences, students struggle in learning how to gain confidence from data, decide the best "evidence" for dissemination, and deal with software or other technical issues while interpreting data; especially because students tend to believe that there is a "correct way" to present visual data instead of creating visual evidence rhetorically-oriented. Therefore, the ultimate learning goals of such interventions are to help students to a) make decisions according to their audiences by selecting a "meaningful" subset of "raw data" (i.e., using data to "make a case" of their work); b) describe detailed explanations of the findings; and, c) avoid forcing data to fit in a theory to rather identify "interesting findings" (Poe, Lerner & Craig, 2010).

Regarding engineering genres to teach, proposals, progress reports, and completion reports are mentioned (Artemeva, 2005). Job applications and cover letters are also suggested as senior genres instead of introductory genres, because senior genres are not easy to enact by freshman or junior students when they have no experience in workplace cultures; thus, the student-writer has no incentive to look carefully and reflectively at past experiences to find applicable strategies. Ultimately, these writing tasks might have no relevance beyond the grade for novice students (Quick, 2012).

Teaching academic research skills needed in workplaces is also highlighted in the pedagogical agendas through, for instance, encouraging students' publication of capstone experiences that address audiences beyond classrooms. These initiatives are undertaking by the following stages: a) literature review and research about a specific topic of the field; b) oral presentations for department staff and guests (practitioners); c) conference presentations; and, d) journal submissions. These initiatives also advocate for expanding students' awareness on academic and professional publication in industry by conducting journal internships. These experiences not only help students to learn how to write to be published but also how to manage the publishing backstage: the administrative side of communicating with reviewers and authors, as well as the technical side of journal production by web design, content management, website updating, and e-journal promotion (Ford & Newmark, 2011).

4. Teaching technical communication from a rhetorical approach

Since there are coexisting teaching approaches that might become contradictory, teaching on technical writing and communication as rhetorical practices is strongly encouraged to defy the positivist view of knowledge. For instance, technical writing teaching that maintains the legacy of positivist perspectives is focused on style, organization, and tone, and the analysis of audience in terms of primarily adapting vocabulary of texts. These teaching contents reinforce the value of effective prose as if scientists indeed transmitted “physical realities” by writing (e.g., emphasizing the use of strategies as impersonal voice). Conversely, within rhetorical approaches, one of the subject matters must be “science as argument”, which implies learners of technical communication become persuasive professionals embedded in rhetorical situations of scientific and technological domains (Miller, 2004).

In doing so, learning experiences must include projects to interact with different audiences and conduct shared assignments (i.e., across disciplines, different degrees of expertise, academic and industry audiences, different types of stakeholders within and across organizations). In shared assignments, language assumes the function of satisfying a real need outside of the language classroom (Tatzl, Hassler, Messnarz & Flühr, 2012). However, this effort is challenging because of the heterogeneity of student population in classrooms in terms of their expertise and field affiliations, especially in the case of BTC courses of general education requirement (MacDaniel & Steward, 2011). Team teaching among researchers, practitioners, language instructors, and disciplinary instructors is acknowledged as a pedagogical strategy, but it is rarely implemented due to high costs. Additionally, in these types of initiatives it is not enough to expose students to diverse audiences, because even when they are immersed in an actual workplace setting and are assigned authentic writing tasks, students might not fully understand the implications of their work because they are accustomed to write for pleasing a single-person audience (the instructor) and to earn a grade. Therefore, students need scaffolding when work on writing tasks for real workplace audiences (Quick, 2012).

Also, studies of communication skills required by workplace settings have called for curriculum reforms to meet needs of organizations (Reave, 2004). One of the goals is to design learning experiences that expose students to diverse communicative and writing practices according to different organizational positions that students could achieve in their professional future, which includes internships and interdisciplinary curriculum that teach about management and business reasoning (MacDaniel & Steward, 2011).

5. Assessment agendas

Regarding assessment in technical communication programs, some scholars suggest institutional assessment of curriculum and learning outcomes according to institutional values of universities; this type of assessment can provide insights for planning (Allen, 2010). Concerning student performance and learning outcomes, assessment on “polymorphic literacy” (i.e., writing as a performance that involves both images and language) is also advised. Moreover, learning assessment of changes in students’ performances across time is also recommended; for instance, through validated rubrics to be applied to students' writing samples (Coppola & Elliot, 2010)[8].

C. A qualitative analysis of publications that report Latin-American writing initiatives in engineering

This section presents a qualitative analysis of publications that report Latin-American endeavors (initiatives or studies) in engineering writing. This analysis provides a map that will be later discuss within the agendas on research and teaching of technical communication programs in the U.S. just described in the prior literature review.

1. Sample

The scholarship on Latin-American Writing Studies emerges in 1990[9], with freshman composition courses providing the most frequent learning opportunities (see ILEES project at http://english.ilees.org/). Since there are no central venues (either journals, professional associations, or open-access projects)[10] to easily access to literature on writing studies and disciplines in Latin America, the sample presented in appendix 1 for this analysis was comprised of 22 publications (journal articles and oral communications) collected from Latin-American colleagues during Summer 2014 and by searching in the first International Data Base on Latin-American reading and writing studies that was launched in December

[8] The assessment agendas in the U.S. for technical communication programs have been highly influenced by accreditation agencies as ABET, which in pursuing its mission has included issues of communication and writing as part of the factors involved "(…) *in assuring quality and stimulating innovation in applied science, computing, engineering, and engineering technology education*". Information taken from: ABET Vision. (n.d.). Retrieved February 25, 2016, from http://www.abet.org/about-abet/vision-and-mission/

[9] In this study is acknowledged that before 1990 teaching initiatives of academic reading in English have been undertaken in the Latin-American Region (e.g., Argentina, Brazil, Chile, and Colombia). However, the current exploration is focused on teaching disciplinary and professional writing in engineering fields.

[10] Although data collected in the ILEES Project also confirms that there are journals affiliated to Linguistics and Language sciences that have become venues for publications. For instance, *Signo y Seña* (Universidad de Buenos Aires, Argentina), *Signos* (Pontificia Universidad Católica de Valparaíso, Chile) and *Lenguaje* (Universidad del Valle, Colombia). Additionally, there is a Colombian network for Reading and Writing in

2014 as a result of a research project led by a Colombian scholar (Cisneros, 2014) (See the project at: http://www.utp.edu.co/vicerrectoria/investigaciones/publicaciones-lectura-escritura/).

2. Data creation and analysis

Titles, abstracts, and sections of conclusions and discussion of the publications (journal articles and oral communications) of the sample were read to explore the categories presented below and developed partly from the literature review:

a) Years and countries of the publications.
b) Emphasis of the publications (pedagogically-oriented, research-oriented, or research on pedagogical experiences).
c) Engineering fields associated with the initiatives/studies.
d) To what extent the initiatives/studies have been institutionalized and interdisciplinary
e) To what extent the initiatives/studies are explicit on the type of language is addressed/studied (linguistic systems; mathematical and linguistic systems, and multimodal systems).
f) To what extent computers are mentioned in the initiatives/studies.
g) For pedagogically-oriented publications, the analysis aimed at identifying curriculum learning moments (i.e., freshman, sophomore, junior, and senior years for undergraduate and graduate programs), across several college terms (Writing across the curriculum), or after/outside of curriculum experiences (practitioners/professionals).

Higher Education, with the Acronym "REDLEES" in Spanish. (Cf. http://ascun.org.co/red/detalle/red-de-lectura-y-escritura-en-educacion-superior-redless).

h) The analysis also aimed at categorizing reasons for studying or leading initiatives on engineering writing. The following sub-categories were created based on the literature review and other new categories emerged from the data:

- Writing to learn (WL)
- Writing for scientific practices (WCP)
- Writing for professional practices (WPP)
- Writing for Writing Research (WWR)
- Senior thesis writing (STW)
- Reading for learning (RL)

i) The analysis of the publications also explored what might count as “genre”. There is a methodological debate in the field of Genre Studies about theoretical and methodological limitations in describing and labeling genres (Devitt, Bawarshi and Reiff, 2003; Herrington & Moran, 2005; Gardner & Nesi, 2012); therefore, the following categories were defined to analyze the notion of “genre” as a theoretical entity based on the overview presented by Bawarshi and Reiff (2003):

- An individual textual-linguistic entity.
- As a group of linguistic, textual, and/or rhetorical patterns of language use that has been called "genre families” or “genre repertoires”.
- As a language usage and circulation enacted by different participants/roles within discourse communities and actual institutions (genre systems).

Appendix 2 presents the categories, its descriptions, and examples of original fragments with cases of the sample.

The analysis of topics reported as conclusions, limitations, and implications in the publications was also conducted to identify agendas stated by the author(s) of the documents analyzed. The sections of conclusions and discussion were read to infer the main claims stated by the authors. Appendix 3 illustrates some examples of the grounded categories with original fragments of the publications analyzed.

Given the size and type of the sample (22 publications were collected as a convenience sample), the analysis of the prior categories was done by counting numbers of occurrences when were identifiable, and the results are descriptive.

3. Results

This section summarizes the results by grouping the categories of the analysis in three clusters:

3.1) Descriptive features of the initiatives/studies reported by the publications (categories a, b, c, d, e, and f);

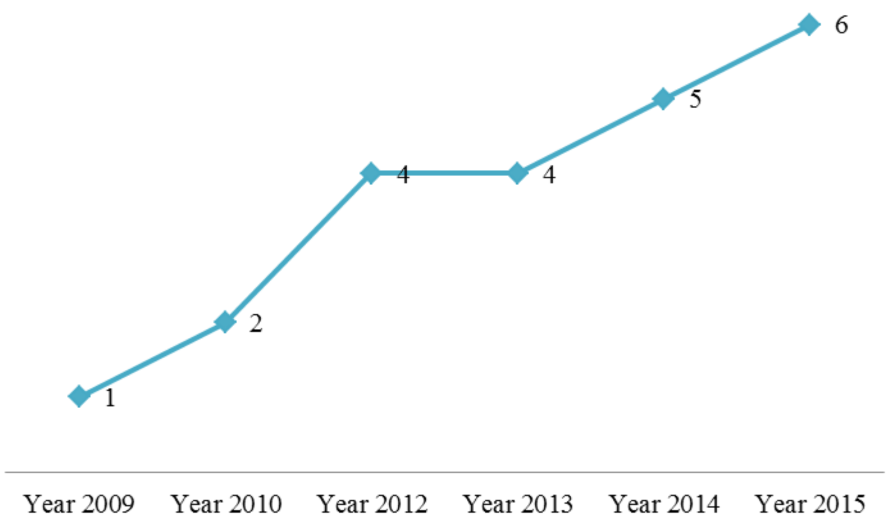
3.2) Reasons for studying or leading initiatives on engineering writing (category h), genre approach (category i), and types of genres (categories g); and,

3.3) Agendas framed by conclusions, limitations, and implications of the publications

3.1. Descriptive features of the initiatives/studies reported by the publications

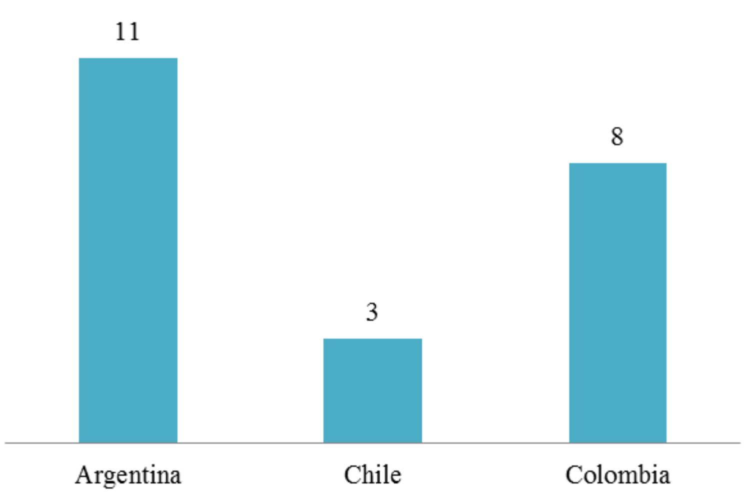
The initiatives/studies on engineering writing might be recent in Latin-American Region. The oldest paper of the sample was published in 2009. However, after 2010 there was a growth in the number of publications according to the data behavior in previous years (figure 1).

Figure 1
Occurrences of the publications by year



The analysis of the sample suggests that Argentina, Colombia, and Chile might be the leading countries of the initiatives/studies that are published either as journal articles or oral communications. However, Argentina might be the country in which more publications have been produced (11 cases) (figure 2).

Figure 2
Occurrences of the publications by country



The initiatives/studies have been disseminated evenly by oral communications (10 cases) and journal articles (12 cases). The publications were primarily pedagogically-oriented by reporting either experiences or research on pedagogical experiences (14 cases), in contrast to papers that were research-oriented but not related to pedagogical experiences (8 cases). The following is an example of a Colombian pedagogically-oriented publication in which writing is used to support student learning in a class of electronic engineering[11]:

Example 1
Article title: "Integration of reading and writing in the laboratory course of electronic devices in Electronic Engineering" (2014)

> *This paper presents a model integrating reading and production of scientific texts as tools to build disciplinary knowledge. In doing so, the goal is to develop critical and analytical thinking, and communication skills of students enrolled in the course "Laboratory of electronic devices", one of the core experimental courses of the major in Electronic Engineering program at the University del Valle.*

Another example of a research-oriented publication is as follows, in which a study is conducted to explore academic and professional genres required during undergraduate education in Industrial Engineering in a public Argentine university:

Example 2
Article title: "Genres and engineering education: from university to the industry" (2015)

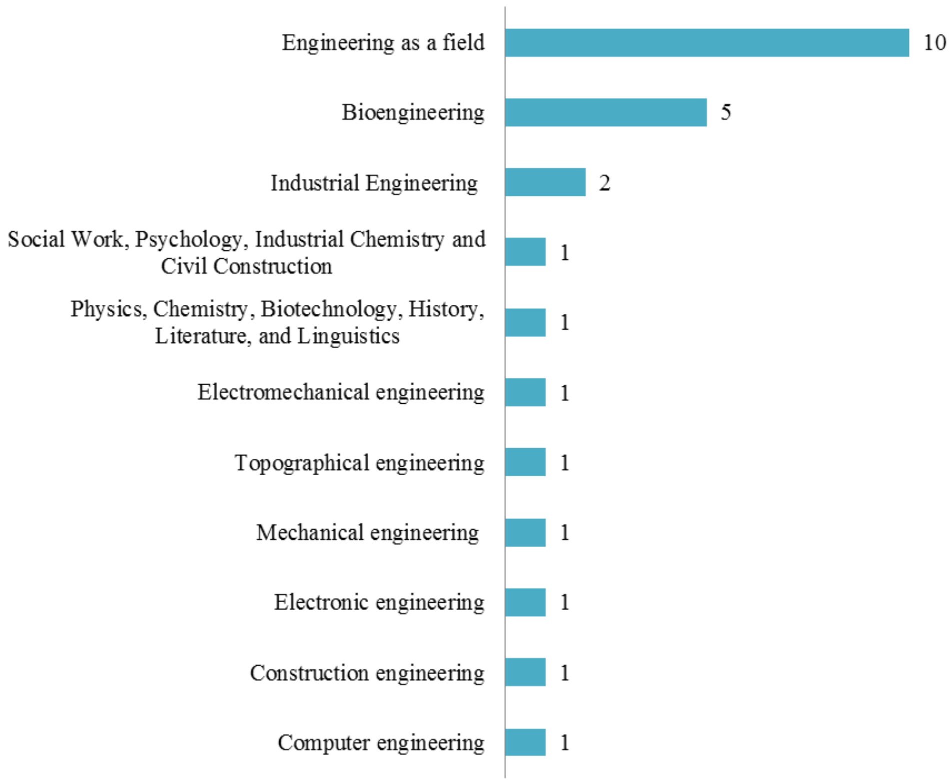
> *This article reports the results of the first stage of a research on academic and professional genres required during undergraduate education in Industrial Engineering in a public Argentine university. This study includes three sites to study genres: faculty members and students, as participants, and texts, as products. This paper reports faculty members' perspective collected by interviews to explore what genres are required in the academic training of industrial engineers, and analyzes how these genres are distributed throughout the program. Furthermore, it is analyzed the interplay between knowledge production and professional practices promoted by college education. Ultimately, this exploration sheds insights for pedagogical interventions that advocate for disciplinary literacy, and smooth transitions and insertions in industrial professions.*

[11] In this section some fragments of the actual publications are used to illustrate the analysis. Since most of the original data is in Spanish, the cases were translated into English. These translations were done by *Ingrid Julieth Hernández Cuero*, senior student of the Degree in Foreign Languages of the *Universidad del Valle* in Colombia.

The research oriented publications were journal articles (appendix 4), whereas the publications pedagogically-oriented, including those that are research on pedagogical experiences, were both journal articles (JA) and oral communications (OC) (appendices 5 & 6).

The initiatives/studies address primarily “engineering” as one field (10 cases), while less common are the initiatives/studies bounded by engineering subfields (figure 3).

Figure 3
Engineering fields mentioned by the studies/initiatives



Regarding institutionalization and interdisciplinarity, the sample suggests that the studies/initiatives have been conducted as interdisciplinary efforts between writing instructors and disciplinary-professors or practitioners (16 cases out of 22). The following fragment illustrates this tendency by reporting an initiative about an interdisciplinary team teaching between a writing instructor and an engineering instructor for a class in Materials Resistance:

Example 3
Article title: "Summaries as a learning strategy" (2012)

> ***Summary***
>
> *This article presents the findings of an interdisciplinary study on summary writing as a learning strategy which was carried out by a language professor and an engineering professor in the Materials Resistance course, offered to Universidad del Valle engineering students. The ultimate purpose in using this strategy was to raise students' consciousness about the key role of writing in their learning process. Unlike traditional summary writing, these ones were not written for the professor for him to assess whether the students had reviewed course contents. Instead, summaries provided the students with an opportunity to monitor their own learning process and express what they had learned in a written format. A portion of the class session was devoted to check students' production, so that they could assess self-progress. A quantitative-qualitative methodology was used to analyze the experience which was based on data collected by means of a survey and records of class interventions. This analysis shows that introducing students to summary writing as a meta-cognitive strategy had a positive influence on their learning process.*

At least 13 cases of the studies/initiatives reported have implied certain degree of institutionalization (i.e., they have had departmental supports and, have been part of curriculum reforms or product/result of faculty development programs). This tendency is illustrated by the next example about a research project conducted as part of an Argentine institutional program for teaching academic and professional literacy across curriculum:

Example 4
Article title: "Professional literacy during the university career: between the university and the enterprise" (2015)

> ***Abstract***
>
> *Writing practices and the teaching of writing in the university level is a growing research area in which scholars of different disciplines work. This paper presents some partial results of an ongoing research project about writing practices in the Industrial Engineering field. As part of the activities of an institutional program for teaching academic and professional literacy across the university curriculum (PRODEAC) developed at Universidad Nacional de General Sarmiento (UNGS), we surveyed a group of engineers in order to analyze the genres employed in professional settings. Secondly, we asked students working in different companies to tell us which genres they had already used a) at work and b) in the university assignments. In contrast with the findings of previous research work carried out in Spain and Chile, we have found out that students in different courses produced 20 of the 33 genres*

required in the companies. We have also identified the genres we need to describe and include them in the pedagogical designs of the subjects.

Other examples of these cases are presented in appendix 7.

In 16 cases in the sample, it was not possible to identify the type of language addressed/studied in the initiatives/studies of the publications; however, the cases analyzed suggest that there is an attempt to address linguistic and mathematical systems by articulating them (4 cases), as well as see language as a multimodal system (1 case). The following case illustrates with a research project that aimed at describing and quantifying multisemiotic artifacts emerging from a Chilean corpus collected in twelve PhD programs:

Example 5
Article title: "Multisemiosis and corpus linguistics: multisemiotic artifacts in the texts of six disciplines in the academic pucv-2010 corpus" (2010)

ABSTRACT
From strictly linguistic studies, the characterization of multisemiotic written specialized texts has been scarce or almost null. Not many corpus-based studies focus on the description of graphs, tables, and diagrams, as well as their layouts, as part of academic texts. The objective of this study is to identify, describe and quantify the occurrence of (multi)semiotic artifacts which are present in a sample of texts (1.043) belonging to the PUCV-2010 Academic Corpus. The corpus was collected in twelve PhD programs in six Chilean universities and comprises all the documents students are given to read during their formal curricula, with the exception of those included in the final doctoral research (3,160 written texts, which are distributed among Physics, Chemistry, Biotechnology, History, Literature, and Linguistics). As part of the results, nine artifacts were identified and defined, based on the distinction of four semiotic interacting systems: verbal, graphical, mathematical, and typographical. Interesting differences are detected between Basic Sciences (BS) and Social Sciences and Humanities (SS&H), due to the prototypical type of artifacts and also considering the quantification of their occurrence across disciplines.

Furthermore, computers were mentioned as part of the initiatives/studies in 3 cases of the sample (reported in three publications of the same pedagogical experience). The case below shows these types of mentions in an Argentine action-research experience in which students were asked to perform computer assignments in a calculus course:

Example 6
Article title: "Early error detection: an action-research experience teaching vector calculus" (2013)

> *This paper describes an action-research experience carried out with second year students at the School of Engineering of the National University of Entre Ríos, Argentina. Vector calculus students played an active role in their own learning process. They were required to present weekly reports, in both oral and written forms, on the topics studied, instead of merely sitting and watching as the teacher solved problems on the blackboard. The students were also asked to perform computer assignments, and their learning process was continuously monitored. Among many benefits, this methodology has allowed students and teachers to identify errors and misconceptions that might have gone unnoticed under a more passive approach.*

3.2. Reasons for studying or leading initiatives on engineering writing, genre approach, and types of genres

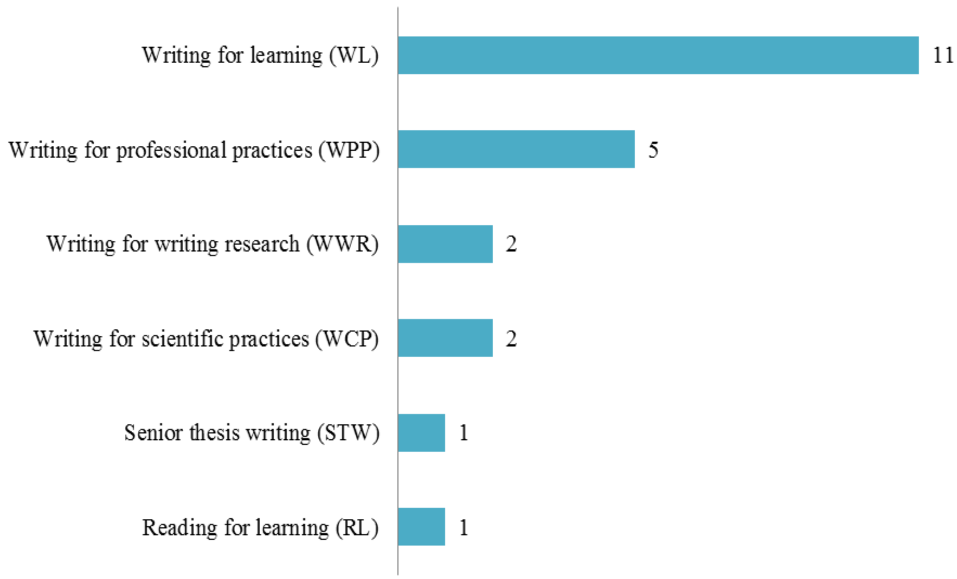
The analysis of reasons for studying or leading initiatives on engineering writing suggests that the initiatives/studies of the sample have been primarily focused on incorporating writing to learn (11 cases in figure 4). The following case illustrates this tendency by presenting a fragment of a Colombian pedagogically-oriented publication in which writing assignments were the core of a pedagogic intervention in a course of computer engineering:

Example 7
Article title: "Writing as a means of learning and communication in the Engineering Software Processes course. Collaborative work between language teachers and those of other disciplines" (2014)

> *This paper aims to analyze on writing guidance and assessment offered in a course titled "Software Engineering Processes" and its impact in students for learning content knowledge. The research relies on theoretical frameworks on Academic Literacy and Writing across the Curriculum. Writing assignments were designed collaboratively between the instructor of the course and a writing instructor. A case study was conducted based on this experience. The information was collected from different sources: surveys from the students at the beginning and end of the semester, discussion group with the students; a depth interview with the instructor of the course; registration logs of team work meetings between both of the instructors; and textual and content analysis of writing guidelines and evaluation rubrics, and students' productions. The results show as influential elements in the learning process: instructors' guidelines, evaluation rubrics, instructor's feedback, student-teacher conferences, assigning writing tasks with specific purposes, as well as opportunities to write drafts and present progress. The collaborative work between instructors it is a possibility to strengthen the epistemic function of writing to learn in subject matters. This type of team work not only helps*

in learning disciplinary content knowledge, but also enhances writing competencies of students and fosters changes of pedagogical practices of instructors.

Figure 4
Reasons for studying or leading initiatives on engineering writing



This trend might be also related to the tendency of the sample of mentioning genres as textual- linguistic entities (14 cases) (out of 14 cases, 4 publications are research-oriented, 6 publications are pedagogically-oriented, and 4 publications are research on pedagogical experiences). The following fragment illustrates these cases by presenting an excerpt of an Argentine study about a pedagogic intervention focused on a professional engineering genre named “the yearly memory”:

Example 8
Article title: “Professional genres in the engineer learning process” (2013)

Introduction
(...) In this research, we present a didactic design that articulates research work about professional writings with the disciplinary contents based on the teaching of a professional genre. More specifically, it is about an experience that took place in the Economy Elements for Engineers course of an engineering program in which the specific teaching of a professional genre and the yearly memory are addressed in relation with other contents of the course program different unties. The main goal was to promote the approaching of the student to the professional field, through role

play in written and oral format. Below, the program framework is briefly described presenting the experience we want to communicate, then there is the course description; afterwards, the methodology and the developed proposal are detailed; finally, some conclusions are drawn.

A list of the publications that mention genres as individual entities is presented in appendix 8.

This tendency on writing to learn approach throughout the publications might be also connected with some of the types of genres mentioned in the sample (i.e., writing assignments, summaries, and computing-laboratory tasks) (table 1).

Table 1
Occurrences of individual genres mentioned in the publications

Individual genres	Occurrences
Writing assignments	3
Computing laboratory tasks	2
Summaries	2
Annual report	1
Lab reports	1
Reports of formative research experiences	1
Mathematical texts	1
Pedagogic journal	1
Research report	1
Standardized operating procedure	1
Textbooks	1
Weekly reports for solving problems with theoretical justifications	1

The initiatives/studies have been focused on different learning moments (when identifiable): undergraduate freshman years and across undergraduate curriculum: 3 cases each; undergraduate sophomore and junior years: 2 cases each; and, undergraduate senior and practitioners: 1 case each (table 2) (out of 12 cases that mention learning moments associated with initiatives or studies, 4 publications are research-oriented, 6 are pedagogically-oriented, and 2 are research on pedagogical experiences).

Table 2
Occurrences of learning moments in which writing is incorporated by the initiatives pedagogically-oriented or genres that are studied in different learning moments

Learning moment	Occurrences
Undergraduate senior (US)	4
Undergraduate junior (UJ)	3
Across undergraduate curriculum (AUC)	3
Undergraduate freshman (UF)	3
Former students (FS)	2
Undergraduate sophomore (USP)	2
Graduate sophomore	1
Practitioners (P)	1

The qualitative distribution of individual genres mentioned by the publications of the initiatives pedagogically-oriented confirms that in freshman and sophomore years one of the pedagogical goals of the initiatives has been writing to learn (i.e., computer laboratory tasks, reading mathematical texts, and weekly reports for solving problems with theoretical justifications). In junior and senior years, research-oriented writing seems to have been incorporated (e.g., research reports) (table 3).

Table 3

The genres mentioned in different learning moments of the initiatives pedagogically-oriented

Learning moment	Genre 1	Genre 2	Genre 3	Genre 4
Freshman undergraduate	Computing laboratory tasks			
Sophomore undergraduate	Reading mathematical texts	Weekly reports for solving problems with theoretical justifications	Lab reports	Computing laboratory tasks
Junior undergraduate	Summaries	Research reports		
Senior undergraduate	Reports of formative research experiences			
Writing across the curriculum	Writing assignments			`

3.3. Agendas framed by conclusions, limitations, and implications of the publications

The analysis of the topics of the conclusion sections suggests that the three most frequent topics mentioned throughout the publications are:

a. Writing to learn is associated with improving student engagement (7 cases);
b. Writing to learn is correlating with approving the classes (7 cases); and,
c. Interdisciplinary work is an opportunity (6 cases) (see appendix 9 with occurrences of the topics in the conclusion sections).

The next case is an illustration of a fragment of conclusions implying the trend of the sample in the approach “writing to learn”. According to the evaluation of an Argentine pedagogic intervention that was relying on writing weekly reports, it seems that some of the students considered the approach very demanding:

Example 9
Article title: "Improvement of Mathematics teaching and learning in Bioengineering: a challenge assumed from action research" (2012)

> *A survey was designed and implemented to the students in the courses 2008, 2009 and 2010, with the purpose of evaluating their perception of the weekly report realization. The questions and their results are shown in figure 3. It is shown that in average, the 85% of the students consider the experience as helpful and necessary for a better performance, since it helped them to understand concepts and correct mistakes. On the other hand, the 15% of the students said the experience was not positive, most of all for the lack of respect of individual learning pace of students and for being too demanding in terms of time.*

The tendency of the publication in the approach "writing to learn" might be also related to the fact that the publications (either oral communications or journal articles) were primarily pedagogically-oriented, or reporting research on pedagogical experiences (see appendix 10). This trend of pedagogically-oriented initiatives is also related to the occurrences identified under the category "reasons for studying or leading initiatives on engineering writing" of the publications mentioned earlier, which also suggests that the initiatives/studies of the sample have been primarily focused on incorporating writing to learn (figure 4).

Furthermore, the third frequent mention in the conclusion sections related to positive evaluations of interdisciplinary work (6 cases) undertaken by the initiatives/studies confirms that interdisciplinarity has been a feature of the initiatives/studies undertaken (16 cases).

The specific conclusion about "Interdisciplinary work is an opportunity (IO)" emerged in 5 cases in publications pedagogically–oriented (3 publications of research on pedagogical experiences, and 2 publications pedagogically-oriented), and 1 case in a research–oriented article (appendix 11).

The analysis of the topics on limitations stated by the publications also suggests that the writing advocates demand certain material conditions particularly related to class sizes in the cases of initiatives/studies pedagogically-oriented (appendix 12); for instance, when the amount of students is mentioned in the following Argentine case as a hindering issue in incorporating writing as part of the engineering courses:

Example 10
Article title: "Creating an educational research space in an engineering department" (2009)

> *Regarding the negative aspects and difficulties in its implementation, "it is difficult to distribute the time between the control of individual work and group discussion to explain the subjects in which frequent errors of the group are detected". "The high number of students by section hinders a more personalized monitoring".*

Furthermore, it is stated that despite the writing supports introduced by these initiatives, the students still struggle in developing audience awareness. This limitation mentioned by the publications might be related to the "genre approach" and types of genres that are frequently mentioned in the initiatives. In other words, if writing initiatives are primarily incorporating writing of genres to support learning in the classes (i.e., summaries, lab tasks, and weekly reports), it is expected that the audiences of these types of writing are mainly instructors and students make no efforts to address other audiences.

The analysis of the trends on further implications derived from the studies/initiatives reveals that the writing advocates envision studies to explore disciplinary features of writing and communication in engineering as well as professional genres. For this type of implication, "Designing teaching material disciplinary-oriented (DM)", out of 6 cases, 4 publications are research-oriented, and 2 are pedagogically-oriented. This particular implication is regarded as useful to inform pedagogical initiatives across the curriculum and design teaching materials and resources. The following fragment illustrates these cases by presenting an excerpt of a Chilean study describing multisemiotic artifacts from a corpus of readings at PhD levels, which is regarded as a useful step to inform material and curriculum design:

Example 10
Article title: "Academic and professional genre Variation across four disciplines: Exploring the pucv-2006 corpus of Written Spanish" (2010)

> *Research studies as the one described here also have pedagogical implications concerning: (a) the selection of written genres, (b) the elaboration of teaching materials, and (c) the preparation of language tests of various kinds, such as the assessment of disciplinary contents and of specialized discourse comprehension.*

Furthermore, this analysis also reveals that the authors of the publications are arguing for envisioning pedagogical initiatives that bridge academic and professional writing practices in engineering, which might suggest that it is already acknowledged this double nature of writing and communication in the engineering field (appendix 13). The three publications that are suggesting to bridging academic writing practices and professional writing practices are research-oriented (appendix 14).

4. Summary of tendencies of Latin-American writing publications on engineering initiatives and studies in Spanish speaking countries

Since about 2009, there have been undertaken systematic writing initiatives and studies on engineering writing and communication in Latin America; particularly, the sample reveals an emphasis on pedagogically-oriented publications, either for documenting pedagogical initiatives or conducting research on the pedagogical interventions that seem to have had certain degree of institutional supports or exigencies (i.e., departmental supports, curriculum reforms, or faculty development programs). Consequently, to date, these types of initiatives might be fruitful research niches from which data could be created to conduct studies on the impact of the initiatives.

Whether engineering writing/language was considered as a multimodal phenomenon, was not easy to track from the sample; however, the initiatives/studies reported by the publications of the sample have tended not to have yet considered interplays between verbal and non-verbal semiotic systems in engineering. However, there were Latin-American publications of the sample that report on initiatives or research in which verbal and mathematical systems are seen as articulated to support student learning (Añino et al. 2009; 2010; 2012; 2013), or where researching on engineering texts implies adopting a multimodal approach, namely, analysis of both the presence and interaction of verbal and non-verbal representations (Parodi, 2010c).

The tendency of the sample seems to have been focused on engineering as one field and on investigating or carrying out pedagogical interventions of genres to support learning (writing to learn). This pattern suggests that further studies might be useful in exploring disciplinary features of initiatives/studies by subfields in engineering and its disciplinary and professional practices of writing and communication (e.g., mechanical engineering, biomedical engineering, industrial engineering). If writing advocates hold a disciplinary writing hypothesis, this type of studies are imperative for aggregating data to the field on Writing Studies. In fact, this research implication emerged as one of the topics mentioned in the publications analyzed. The writing advocates of the publications of the sample envision studies to explore disciplinary features of writing and communication in engineering as well as professional genres in order to inform practices on pedagogical initiatives across the curriculum and designing teaching materials and resources.

D. Discussion

In the Latin American case, there is no specific field equivalent to Technical Communication as developed in the U.S.; however, there is a body of emerging Latin-American writing initiatives and studies in engineering. Therefore, this section envisions further research agendas for emerging Latin-American Writing Studies in engineering by comparing the literature review on the teaching and research agendas of technical communication programs in the U.S., and the summary of the tendencies emerging from the Latin-American publications analyzed of Spanish Speaking countries.

The status of the field in Latin America

This analysis suggests that Writing Studies in engineering are an emerging field in the Latin-American region (less than a decade in existence) and with a specific trend of being pedagogically-oriented (Añino et al. 2009; 2010; 2012; 2013; López & Ramírez, 2012; Natale & Stagnaro, 2012; Stagnaro & Florencia, 2013; López & Martínez, 2014; López & Ramírez, 2014; García et al., 2014; Gómez, 2014; Rodríguez & Valderrama, 2014; López y Natera, 2015).

The initiatives seem to be institutionalized as part of departmental supports, curriculum reforms, and faculty development programs (Añino et al. 2009; 2010; 2012; 2013; Natale & Stagnaro, 2012; Stagnaro & Florencia, 2013; García et al., 2014; Gómez, 2014; Rodríguez & Valderrama, 2014; Natale & Stagnaro, 2015). In contrast to the U.S. scholarship, the Latin-American publications analyzed do not report any quarrels regarding the status of the technical communication instructors, programs, or initiatives (Russell, 2007; Rude, 2009; Reave, 2012).

The analysis of Latin-American publications that report on initiatives pedagogically-oriented suggests that the field has emerged primarily focused on the approach "writing to learn"; however, designing writing initiatives on preparing students for workplace communicative practices (Russell, 2007) emerges as a topic of the conclusions, limitations, and implications of the publications analyzed. For instance, as part of the conclusion sections, some of the publications aimed at a) exploring if professional genres have been taught in college years (2 cases in appendix 9) (Natale & Stagnaro, 2015; Natale, 2015); b) differentiating between professional genres and academic genres (1 case in appendix 9) (Parodi, 2010a); and, c) collecting samples of professional situations from instructors in senior years (1 case appendix 9) (Añino et al., 2010).

Regarding limitations and further implications related to professional genres, the publications mentioned, for instance, that there is a lack of descriptions of professional genres to inform curriculum design (1 case in appendix 12) (Natale & Stagnaro, 2012); thus, further research on professional genre is suggested (4 cases in appendix 13) (Natale & Stagnaro, 2012; Stagnaro, Chiodi & Miguez, 2013). Moreover, incorporating professionally-oriented tasks from freshman years is also stated as an implication of the publications (in appendix 13) (Parodi, 2010a; Natale & Stagnaro, 2015; Natale; 2015).

The analysis of conclusions and limitations of the publications suggests that in the Latin-American case it is not visible, at least in this sample, tensions related to humanities, professional, and science communication approaches (Maylath, Grabill & Gurak, 2010; Yeats & Thompson, 2010).

Furthermore, in the Latin-American case, interdisciplinarity (e.g., writing instructors and disciplinary professors or practitioners) is praised through topics of the conclusions (6 cases in appendix 11) (Añino et al., 2011; Gómez, 2014; López & Martínez, 2014; López & Molina, 2015; Natale & Stagnaro, 2015) and envisioned as a further implication (1 case in appendix 13) (Añino et al., 2010). This Latin-American climate in favor of interdisciplinarity might be also associated with the most frequent type of pedagogical goal undertaken thus far: "writing to learn", since the type of writing assignments might count as low-stake writing assignments (i.e., summaries and weekly reports for solving problems in table 1 and 3) that do not necessarily introduce room for critical stances or contradictory systems of values either for students or instructors involved in the initiatives (for both, engineering professors and writing advocates). Possibly, when teaching on professional and scientific writing and communication is incorporated in the Latin-American region, different negotiations with disciplinary professors and practitioners might create spaces to start conversations about objectivity or rhetorical production of professional and scientific knowledge in engineering.

As happens in the U.S. scholarship, there is an interest reported by some of the Latin-American publications in pursuing research agendas for providing information about transitions and overlapping practices between industry and academic settings (Bernhardt, 2002; Parodi, 2010; Natale, 2015; Natale & Stagnaro, 2015). One of the Latin-American publications analyzed stresses as a limitation that teaching professional genres in classrooms is artificial (1 case in appendix 12) (Natale, 2015), and in three cases the publications claim for bridging academic writing practices and professional writing practices (3 cases in appendix 13) (Parodi, 2010a; Natale & Stagnro, 2015; Natale, 2015).

The U.S. cultural studies perspective making visible and complicating tacit systems of values and commitments on bureaucratic hierarchies, high technologies, and corporate capitalism embedded in the field (Thralls & Blyler, 2002; Miller, 2004) did not emerge from the Latin-American sample. Further analysis of Latin-American publications associated with communication studies and organizational communication, for instance, might provide new insights on this particular issue related to critical studies on writing and communication practices within companies. For now, and according to the sample, it seems that this might be an interesting research topic to explore in the Latin-American case.

The emphasis on writing to learn and the little call for further research on professional genres (4 cases in appendix 13) might suggest that in the Latin-American case the debate on what should be the goal of the writing courses in engineering is not yet present (at least in the sample analyzed), such as the goal of increasing students' marketability (Selber, 2004). This conflict between professional or humanistic role of writing courses might be further traced in Latin-American publications that report studies or initiatives on FYC courses, since this is the most frequent pedagogical intervention in the region (see information of the project "Writing initiatives in higher education, ILEES Latin America" at http://english.ilees.org/).

The overall analysis shows that research and initiatives on engineering writing are advocating primarily for writing to learn (e.g., some of the most frequent topics of the conclusion sections of the publications analyzed are "writing to learn is correlating with approving the classes" and "writing to learn is associated with engagement"); and the tendency throughout the publications is to mention genres as individual texts to support student learning (i.e., writing assignments, summaries, computer laboratory tasks, reading mathematical texts, and weekly reports for solving problems with theoretical justifications).

These trends suggest that the Latin-American writing advocates in engineering might benefit of incorporating theoretical frameworks for:

a. exploring and understanding different roles of writing across time and curriculum in student learning and by engineering subfields (e.g., differences over time among writing summaries, weekly reports for solving-problems, and lab reports in learning the discipline versus writing professional or research genres); and,
b. exploring theoretical approaches to understand genres beyond isolated textual entities to embed them as part of systems of activity[12] (i.e., genre repertoires and genre

[12] Theoretical category to explain social activity and its organization/reproduction by making visible the overlap and natural contradictions emerging from the interaction between a) social goals of communities/groups and personal motives of individuals within and across organizations/communities/groups, with b) division of labor, social roles, hierarchies and power, systems of values, status quo vs. innovation, and access/creation of artifacts (either material or symbolic).

systems[13]), which implies to rethink curriculum initiatives and studies under the assumption that students as further practitioners of their disciplines will be exposed to a spectrum of roles as genres users (either as readers or writers) and as part of complex overlapping activities impacted by issues of hierarchy and power within organizations.

Digital technologies

Regarding issues on computer literacy, the publications of the sample mentioned computers only in three cases, but they were related to the same Argentine experience (Añino et al., 2010a; 2010b; 2012; 2013). In this case, computer literacy was not part of the teaching contents (Selber, 2004); instead, computer assignments are means to support students in learning disciplinary content of the class (i.e., writing to learn).

Subject matter of the courses

Specific experiences of research or pedagogical initiatives on creating data and evidence in scientific writing in engineering (Poe, Lerner & Craig, 2010) did not emerge either from the sample of the publications analyzed. However, some Latin-American publications report initiatives in which verbal and mathematical systems are seen as articulated to support student learning, or research on engineering texts that implies adopting a multimodal approach, namely, analysis of both the presence and interaction of verbal and non-verbal representations (Parodi, 2010c).

In the U.S. scholarship, there is a debate about when and how to teach genres related to workplace cultures such as job-applications and cover-letters (Quick, 2012). The analysis of the types of genres mentioned in the Latin-American initiatives/studies (table 3) suggests that

13 Cf. Spinuzzi, 2012; Bawarshi & Reiff, 2010; Russell, 2010; Freedman, 2006; Tardy, 2009; Artemeva, 2006; and, Devitt, Bawarshi & Reiff, 2003.

these types of genres are not part of the initiatives/studies reported by the publications of the sample. Despite the size and type of the sample (a convenience sample of 22 publications), this finding might be explained by features either of the higher education systems (i.e., by further analyzing to what extent in Latin-American engineering majors, students are exposed to internships), or written genres embedded in job applications (i.e., by further analyzing what type of written genres are requested, if any, in Latin-American job markets).

The U.S. scholarship of teaching on science communication and research skills (Ford & Newmark, 2011) might be further explored in the Latin-American case by contextualizing what counts as scientific knowledge production and to what extent is related to higher education in general and to engineering majors in particular. These particular U.S. experiences for teaching genre practices that merge scientific and professional audiences (i.e., literature reviews or oral presentations that are addressing simultaneously academic and industry audiences) (Ford & Newmark, 2011) continue nourishing conversations about the rhetorical nature of scientific and technological production (science as argument) (Miller, 2004). In this regard, it is interesting to mention that in the Latin-American case, two pedagogically-oriented publications mentioned as limitation that students struggle in developing audience awareness (López & Ramírez, 2012; 2014); this difficulty might be also associated with assigning writing activities that are exclusively addressing instructors (writing to learn). Therefore, further research initiatives might collect data to compare how audience awareness is developed over time according to types and amounts of learning opportunities in which students have to address either interdisciplinary, academic, and industry audiences.

Assessment agendas

The U.S. scholarship has acknowledged the importance of conducting assessment of curricula and learning outcomes of the programs according to systems of values of the institutions and majors (Allen, 2010; Coppola & Elliot, 2010). In the case of the Latin-American publications analyzed, the writing advocates are already pointing out the need of conducting developmental research on students writing and genre awareness of faculty members who have been participants of the interdisciplinary writing initiatives in engineering majors (3 cases in appendix 12) (Natale & Stagnaro, 2012; Stagnaro & Jauré, 2013).

E. Conclusion

This chapter aims at exploring features of Latin-American writing initiatives in engineering reported by publications (journal articles and oral communications) of Spanish Speaking Countries to map programs pursued in the Region and then provide a context to envision further research agendas for Latin-American Writing Studies in engineering.

The data suggest that the Latin-American movement might have started under the approach of writing to learn. Possibly, it might be expected that when these Latin-American initiatives and studies incorporate research and pedagogical interventions on professional writing and communication, novel debates will emerge particularly associated with tensions and goals of educating under humanistic and technical approaches of the courses and also regarding the rhetorical nature of scientific and technological production; this climate might further allow integrating critical approaches in the advancement of the Latin-American field.

Furthermore, the trends of the analysis reveal that the Latin-American writing advocates in engineering might benefit by incorporating theoretical frameworks for a) exploring and understanding different roles of writing across time/curriculum in student learning and by engineering subfields and, b) exploring theoretical approaches to understand genres beyond individual texts (i.e., genre repertoires and genre systems).

This analysis also makes visible the need of further exploring features of higher education systems and economic conditions under which science and technology are related to engineering knowledge production as an important context of the emergence of technical communication programs and initiatives beyond the U.S. Additionally, the study confirms the importance of conducting research on development of writing and communication in Latin-American engineering majors, in general, and in the actual initiatives already undertaken, in particular, by identifying disciplinary learning expectations on writing and communication over time.

Appendix 1
List of publications analyzed

#	Title	Interpretation into English	Author(s)	University	Country	Year
2	*Creando un espacio de investigación educativa en una facultad de ingeniería*	Creating an educational research space in an engineering department	María M. Añino, Emiliano Ravera, Diana M. Waigandt, Alberto Miyara, Gustavo Pita, Marisol Perassi	Universidad Nacional Entre Ríos	Argentina	2009
3	Interdisciplinarity: perspectives for the design of Didactic strategies in engineering	The original case was written in English	María M. Añino, Emiliano Ravera, Diana M. Waigandt, Alberto Miyara, Gustavo Pita, Marisol Perassi	Universidad Nacional Entre Ríos	Argentina	2010a
4	Action Research: A way to generate new approaches to teaching mathematics in Bioengineering	The original case was written in English	María M. Añino, Diana M. Waigandt, Marisol Perassi, Gustavo Pita, Alberto Miyara, Ernesto Klimovsky, Emiliano Ravera, Hernán Fernández Céspedes, Leandro Escher, Juan C. Canavelli	Universidad Nacional Entre Ríos	Argentina	2010 b
17	Academic and professional genre Variation across four disciplines: Exploring the pucv-2006 corpus of Written Spanish	The original case was written in English	Giovanni Parodi	Pontificia Universidad Católica de Valparaíso	Chile	2010a
18	*La organización retórica del género Manual A través de cuatro disciplinas: ¿cómo se comunica y difunde LA ciencia en diferentes Contextos universitarios?*	The rhetoric organization of the Manual genre through four disciplines: how is science communicated and spread in the different university contexts?	Giovanni Parodi	Pontificia Universidad Católica de Valparaíso	Chile	2010 b

19	Multisemiosis and corpus linguistics: multisemiotic artifacts in the texts of six disciplines in the academic pucv-2010 corpus	The original case was written in English	Giovanni Parodi	Pontificia Universidad Católica de Valparaíso	Chile	2010c
1	*Los resúmenes como estrategia de aprendizaje*	Summaries as a learning strategy	Gladys Stella López - Ricardo Ramírez	Universidad del Valle	Colombia	2012
5	*Mejorar la enseñanza y el aprendizaje de la Matemática en Bioingeniería: Un desafío asumido desde la investigación-acción*	Improvement of Mathematics teaching and learning in Bioengineering: a challenge assumed from action research	María Magdalena Añino, Marisol Perassi, Gabriela Merino, Emiliano Ravera, Gustavo Pita, Alberto Miyara y Diana Waigandt	Universidad Nacional Entre Ríos	Argentina	2012
8	*Desarrollo de habilidades de lectura y escritura en la trayectoria académica del ingeniero: la experiencia de un programa desafiante e innovador*	Reading and writing abilities development in the academic process of the engineer: the experience of a challenging and innovative program	Lucía Natale y Daniela Stagnaro	Universidad Nacional de General Sarmiento	Argentina	2012
14	*Dificultades de la escritura de informes de investigación formativa en la educación superior en facultades de Ingeniería*	Difficulties in writing formative research reports at university level in engineering	Julio Cortés Trujillo	Universidad de la Salle	Colombia	2012
6	Early error detection: an action-research experience teaching vector calculus	The original case was written in English	María Magdalena Añinoa, Gabriela Merinoa, Alberto Miyaraa, Marisol Perassia, Emiliano Raveraa, Gustavo Pitaa & Diana Waigandta	Universidad Nacional Entre Ríos	Argentina	2013
7	*Experiencias de formación y de inserción laboral de ingenieros: las voces de los protagonistas desde una*	Learning processes and professional insertion experiences of engineers: the voices of the protagonists from a biographic research	Paola Verónica Paoloni Analía Claudia Chiecher	Universidad Nacional de Río Cuarto	Argentina	2013

	investigación biográfica					
9	*Desarrollo de competencias comunicativas en la formación del ingeniero: una propuesta interdisciplinaria*	Development of communicative competences in the engineer learning process: an interdisciplinary proposal	Daniela Stagnaro, Franco Chiodi y Paula Miguez	Universidad Nacional de General Sarmiento	Argentina	2013
21	*Géneros profesionales en la formación del ingeniero*	Professional genres in the engineer learning process	Stagnaro, Daniela, Jauré, María Florencia	Universidad Nacional de General Sarmiento	Argentina	2013
10	*Integración de la lectura y la escritura en el curso de laboratorio de dispositivos electrónicos de ingeniería electrónica*	Integration of reading and writing in the laboratory course of electronic devices in Electronic Engineering	Duvan Fernando García C, Nathaly Nieto R y Alexander Vera T	Universidad del Valle	Colombia	2014
11	*El cambio de concepción sobre escritura del asesorado tras la revisión entre pares: una experiencia del grupo de apoyo para la lectura y escritura en la facultad de ingeniería*	The change in the writing conception of the advised after peer revision: an experience of the support group for reading and writing in the engineering faculty	Diego Fernando Gómez León	Universidad del Valle	Colombia	2014
12	*Incidencia del grupo de apoyo para la lectura y escritura en la construcción de conocimiento de estudiantes de ingeniería*	The influence of the support group for reading and writing in the knowledge construction for engineering students	Carol Sánchez Rodríguez y Juan Camilo Valderrama Quiñones	Universidad del Valle	Colombia	2014
13	*Escribir para aprender y comunicar en la asignatura Procesos de Ingeniería de Software. Trabajo colaborativo entre docentes de lengua y docentes de las disciplinas*	Writing as a means of learning and communication in the Engineering Software Processes course. Collaborative work between language teachers and those of other disciplines	Karen Shirley López Gil1 y Juan Carlos Martínez Arias	Pontificia Universidad Javeriana de Cali	Colombia	2014

15	*Elaboración de resúmenes, una estrategia de estudio en ingeniería*	Writing summaries, a learning strategy in engineering	Ricardo Ramírez Giraldo y Gladys Stella López Jiménez	Universidad del Valle	Colombia	2014
16	*Orientación y evaluación de la escritura en asignaturas disciplinares. Experiencia de trabajo colaborativo docente*	Orientation and evaluation of writing in disciplinary subjects. A teacher collaborative work experience	Karen Shirley López Gil y Violeta Molina Natera	Pontificia Universidad Javeriana de Cali	Colombia	2015
20	*Alfabetización profesional durante la carrera universitaria: entre la universidad y la empresa*	Professional literacy during the university career: between the university and the enterprise	Lucía Natale Daniela Stagnaro	Universidad Nacional de General Sarmiento	Argentina	2015
22	*Géneros y formación ingenieril: de la universidad a la industria*	Genres and engineering education: from university to the industry	Lucía Natale	Universidad Nacional de General Sarmiento	Argentina	2015

Appendix 2
The categories, its descriptions, and examples of original fragments with cases of the sample

Categories	Description	Examples of original fragments of the cases of the sample	Interpretation into English
a) years and countries of the publications			
b) emphasis of the publications	Pedagogically-oriented	**Case # 10: Page 4** *En este trabajo se propone un modelo de integración de la lectura y la producción de textos científicos como herramientas para construir conocimiento con los dinamismos propios del campo de estudio. En este contexto, se busca desarrollar el pensamiento crítico y analítico y las habilidades comunicativas en los estudiantes del curso de Laboratorio de Dispositivos Electrónicos, uno de los cursos experienciales básicos del programa de Ingeniería Electrónica de la Universidad del Valle.*	**Case # 10: Page 4** This paper presents a model integrating reading and production of scientific texts as tools to build disciplinary knowledge. In doing so, the goal is to develop critical and analytical thinking, and communication skills of students enrolled in the course "Laboratory of electronic devices", one of the core experimental courses of the major in Electronic Engineering program at the University del Valle.
	Research-oriented	**Case # 22: Page 3-4** *En este artículo, se presentan los resultados de la primera etapa de una investigación que estudia los géneros académicos y profesionales demandados durante la formación de grado de una carrera de Ingeniería Industrial de una universidad pública argentina. Dicha investigación contempla tres perspectivas para la aproximación al estudio de los géneros: la de los docentes, la de los estudiantes –los sujetos participantes- y la de los textos –el producto. Aquí, se considera la perspectiva de los docentes recogida en entrevistas para explorar los géneros que se demandan en la formación académica del ingeniero industrial y analizar, luego, cómo se distribuyen a lo largo de la carrera. Interesa también observar las formas de vinculación con el conocimiento y la práctica profesional que son promovidas desde la universidad. Se espera que esta exploración arroje datos útiles para el diseño de intervenciones didácticas tendientes a favorecer el proceso de alfabetización disciplinar y a facilitar el tránsito entre la formación universitaria y la posterior inserción profesional en la industria.*	**Case # 22: Page 3-4** This article reports the results of the first stage of a research on academic and professional genres required during undergraduate education in Industrial Engineering in a public Argentine university. This study includes three sites to study genres: faculty members and students, as participants, and texts, as products. This paper reports faculty members' perspective collected by interviews to explore what genres are required in the academic training of industrial engineers, and analyzes how these genres are distributed throughout the program. Furthermore, it is analyzed the interplay between knowledge production and professional practices promoted by college education. Ultimately, this exploration sheds insights for pedagogical interventions that advocate for disciplinary literacy, and smooth transitions and insertions in industrial professions.
	Research on pedagogical	**Case # 10: Page 3-4**	**Case # 10: Page 3-4**

	experiences	*Esta ponencia presenta los resultados de una investigación desarrollada en el año 2014, en la Pontificia Universidad Javeriana Cali. La investigación se apoyó teóricamente en las perspectivas de Alfabetización Académica y de Escritura a través del Currículo. Se implementó una estrategia en la que docentes de lengua trabajaron conjuntamente con docentes de Ingeniería, Derecho, Administración y Medicina, en cuatro asignaturas propias de esos programas académicos, con el fin de favorecer los procesos de aprendizaje de los contenidos de las materias a través de tareas significativas de escritura. Se realizó un estudio descriptivo; la información se recolectó a partir de distintas fuentes e instrumentos: encuestas a estudiantes, entrevistas a docentes, grupos de discusión y análisis de documentos. En los resultados se destacan como elementos influyentes en el proceso de aprendizaje mediante la escritura: la asignación de tareas con propósitos específicos y con situaciones comunicativas definidas; las orientaciones de los docentes a través de guías escritas y asesorías; la posibilidad de presentar avances de los textos; y la especificación de los criterios de evaluación. También se presenta un análisis comparativo entre los perfiles de los docentes y las características propias de las asignaturas, como un aporte a las posibles formas de trabajo colaborativo entre docentes, ya que se encuentra que esta es una estrategia que puede potenciar la escritura a través del currículo.*	This paper presents the results of a research conducted in 2014 at the Pontificia Universidad Javeriana, Cali. The study relies on theoretical frameworks of Academic Literacy and Writing Across the Curriculum. Writing instructors worked together with instructors of Engineering, Law, Management, and Medicine to facilitate learning of the subject matter of four courses through incorporating meaningful writing assignments. A descriptive study was conducted by collecting information from different sources and instruments: student surveys, interviews with instructors, focus groups, and document analysis. The results show the following influential elements in learning when incorporating writing: assigning writing tasks with specific purposes and contextualized in specific communicative situations; offering explicit written guidelines and guidance by teacher-student conferences; opportunities to produce and present drafts of writing tasks; and, explicit assessment criteria. Furthermore, it is presented a comparative analysis of the profiles of participating faculty members and the characteristics of their subject matters as a contribution for replicating these collaborative team works that can enhance initiatives on writing across the curriculum.
c) engineering fields associated with the initiatives/studies		**Case # 5: Page 1** ***Resumen*** *En este trabajo se exponen las inquietudes y necesidades que, advertidas por un grupo de docentes de la Facultad de Ingeniería de la Universidad Nacional de Entre Ríos (FIUNER), originaron un proyecto de Investigación Educativa de carácter interdisciplinario. Se describen también las dificultades y algunos resultados alcanzados en la realización del mismo. Se aborda la problemática del aprendizaje y la enseñanza de la*	**Case # 5: Page 1** **Summary** This paper presented inquires and needs of a group of professors from the Faculty of Engineering of the National University of Entre Ríos (FIUNER) that catalyzed an interdisciplinary educational research project. Difficulties and some results are presented. Challenges for Math teaching and learning in an engineering interdisciplinary subfield, bioengineering, are presented.

		Matemática en una rama de la Ingeniería intrínsecamente interdisciplinaria: la Bioingeniería.	
d) to what extent the initiatives/studies have been institutionalized and interdisciplinary		**Case # 9: Page 1** ***Abstract.*** *La inserción en la comunidad profesional exige ciertas destrezas comunicativas. Cotidianamente, el ingeniero utiliza el lenguaje como herramienta en situaciones comunicativas orales, escritas o mixtas en las que interactúa con otros y realiza transacciones que requieren competencias comunicativas para transmitir información, dar órdenes, negociar, orientar, comunicar decisiones, consultar, producir conocimiento, controlar actividades o conductas, gestionar información.* *En este contexto, necesita dominar un complejo repertorio de géneros, por lo que su enseñanza resulta fundamental en la instancia de formación universitaria. Aquí, presentamos resultados parciales de una investigación interdisciplinaria sobre los géneros profesionales del ámbito empresarial realizada por ingenieros y lingüistas. Específicamente, nos concentramos en el género procedimiento operativo estandarizado. Los resultados obtenidos señalan que la característica más sobresaliente de este género es la de contribuir al sistema de calidad de la empresa, lo que es retomado desde la propuesta de enseñanza para propiciar el desarrollo de competencias comunicativas en nuestros estudiantes.*	**Case # 9: Page 1** **Abstract.** Professional immersion requires certain communication skills. Engineers uses daily language as a tool in oral, written or mixed communicative situations in which they interact with others to transmit information, give orders, negotiate, guide, release decisions, make consultations, produce professional knowledge, regulate activities or behaviors, and manage information. In this context, engineers need to master a complex repertoire of genres, so genre education is essential since college education. We present partial results of an interdisciplinary research project on professional genres of entrepreneurial environments conducted by engineers and linguists. Especially, we focus on the genre called "standardized operating procedure". Results show that the most outstanding feature of this genre is to contribute to quality systems of companies, which is incorporated into our teaching proposal to enhance the development of communication skills in our students.
e) to what extent the initiatives/studies are explicit on the type of language is addressed/studied	linguistic systems	**Case # 1: Page 1** *Se comparten los resultados principales de un estudio interdisciplinario a cargo de una profesora de lenguas y un profesor de ingeniería sobre los resúmenes como estrategia de aprendizaje en el curso Resistencia de Materiales, ofrecido para estudiantes de ingeniería en la Universidad del Valle, con el propósito de que los estudiantes tomen conciencia sobre sus procesos de escritura y sobre el papel fundamental de la escritura en el aprendizaje. Estos resúmenes, a diferencia de la práctica tradicional, no se escriben para el profesor con el propósito de que este evalúe si el estudiante ha estudiado o no,*	**Case # 1: Page 1** This paper presents the main results of an interdisciplinary study conducted by a writing instructor and an engineering instructor on summary writing as a learning strategy in a course on resistance of materials offered for engineering students at the Universidad del Valle, which aims at supporting students in gaining awareness about their writing processes and the fundamental role of writing in learning. These summaries, unlike traditional practices, are not written for the teacher assessing students' performances; instead, writing summaries is a strategy to help students to revise their learning by writing what they have understood; in-class time, summaries are revised to help students to track their progress.

		sino para que cada estudiante revise su proceso de aprendizaje y exprese por escrito lo que ha entendido; en la clase hay espacio para revisarlos de modo que los estudiantes vean su progreso.	
	mathematical and linguistic systems	**Case # 4: Page 1** From this analysis, it is clear that the Mathematics courses in the Bioengineering curriculum (See Table I) must be planned in such a way not only to foster the acquisition of the necessary mathematical concepts, procedures and methods to cope with the subjects in senior years, but also to contribute towards the development of abstraction, and of critical and reflective thinking. As a result, a strong emphasis should be placed on learning to learn Mathematics This means that the student should be involved in a process of discovery about learning the general mathematical abilities so as to be sufficiently equipped to face the study of new areas of this discipline according to his/her needs and interests in the future. In furtherance of this, it is necessary to adopt a learner-centered approach to stimulate the development of such abilities. Far from being a passive subject the student will have an active role in the teaching-learning process. Although the members of this research team agree with this point of view, designing and implementing new teaching and assessment tools is far from being an easy task for the Mathematics teacher in charge of the course corresponding to the first years of the Bioengineering curriculum. Generally, the groups are numerous and students come from different parts of the Entre Ríos province and from other provinces of our country. Consequently, the mathematics background after high school is diverse. However, this may be taken on as a challenging situation by the teachers.	**Case # 4: Page 1** The original case was written in English
	multimodal systems	**Case # 19: Page 1** **ABSTRACT** From strictly linguistic studies, the characterization of multisemiotic written specialized texts has been scarce or almost null. Not many corpus-based	**Case # 19: Page 1** The original case was written in English

		studies focus on the description of graphs, tables, and diagrams, as well as their layouts, as part of academic texts. The objective of this study is to identify, describe and quantify the occurrence of (multi)semiotic artifacts which are present in a sample of texts (1.043) belonging to the PUCV-2010 Academic Corpus. The corpus was collected in twelve PhD programmes in six Chilean universities and comprises all the documents students are given to read during their formal curricula, with the exception of those included in the final doctoral research (3,160 written texts, which are distributed among Physics, Chemistry, Biotechnology, History, Literature, and Linguistics). As part of the results, nine artifacts were identified and defined, based on the distinction of four semiotic interacting systems: verbal, graphical, mathematical, and typographical. Interesting differences are detected between Basic Sciences (BS) and Social Sciences and Humanities (SS&H), due to the prototypical type of artifacts and also considering the quantification of their occurrence across disciplines.	
f) To what extent computers are mentioned in the initiatives/studies		**Case # 6: Page 3** This paper describes an action-research experience carried out with second year students at the School of Engineering of the National University of Entre Ríos, Argentina. Vector calculus students played an active role in their own learning process. They were required to present weekly reports, in both oral and written forms, on the topics studied, instead of merely sitting and watching as the teacher solved problems on the blackboard. The students were also asked to perform computer assignments, and their learning process was continuously monitored. Among many benefits, this methodology has allowed students and teachers to identify errors and misconceptions that might have gone unnoticed under a more passive approach.	**Case # 6: Page 3** The original case was written in English
g) For pedagogically-oriented publications, the analysis aimed at	Example of "senior" as a learning moment (i.e., freshman, sophomore,	**Case # 7: Page 3** **Abstract**	**Case # 7: Page 3** The original case was written in

identifying curriculum learning moments (i.e., freshman, sophomore, junior, and senior years for undergraduate and graduate programs), across several college terms (Writing across the curriculum), or after/outside of curriculum experiences (practitioners/professionals)	junior, and senior years for undergraduate and graduate programs)	This paper analyzes the experiences of a group of graduates from a university in Argentina. We worked with forty engineers who received their diplomas between 2008 and 2010. Using a longitudinal survey and in-depth biographical interviews, we analyzed their perceptions and values related to the training they received and their processes of labor insertion. The study complements quantitative analysis with biographic-narrative interviews to form a case study. The results are organized along four lines: characteristics of the educational path of the participants, difficulties identified in labor insertion, assessment of the causes associated with said difficulties, and suggestions to improve future training programs. Additionally, the work identified an emergent and transversal dimension that accentuates the potential for the situated perspective of learning to impact curricular designs that give priority to an integral education, oriented towards facilitating the process of labor insertion for graduates.	English
	Writing across the curriculum	**Case # 8: Page 1** **Abstract** Being an engineer requires specific technical knowledge, but also academic language proficiency in order to carry out their professional activities. This paper presents the foundations of an institutional program for teaching academic and professional literacy across the university curriculum (PRODEAC) developed at Universidad Nacional de General Sarmiento (UNGS). One of the Program's aims is to improve the students´ readings kills and their oral and written communication abilities throughout their studies. The article outlines the theoretical, methodological and didactic principles as well as the challenges posed by an interdisciplinary and innovative curricular pedagogical approach.	**Case # 8: Page 1** The original case was written in English
	Practitioners/professionals	**Case # 20: Page 2**	**Case # 20: Page 2**

		Abstract Writing practices and the teaching of writing in the university level is a growing research area in which scholars of different disciplines work. This paper presents some partial results of an ongoing research project about writing practices in the Industrial Engineering field. As part of the activities of an institutional program for teaching academic and professional literacy across the university curriculum (PRODEAC) developed at Universidad Nacional de General Sarmiento (UNGS), we surveyed a group of engineers in order to analyze the genres employed in professional settings. Secondly, we asked students working in different companies to tell us which genres they had already used a) at work and b) in the university assignments. In contrast with the findings of previous research work carried out in Spain and Chile, we have found out that students in different courses produced 20 of the 33 genres required in the companies. We have also identified the genres we need to describe and include them in the pedagogical designs of the subjects.	The original case was written in English
h) The analysis also aimed at categorizing reasons for studying or leading initiatives on engineering writing. **The following sub-categories were created based on the literature review and other new categories emerged from the data:** **-Writing to learn (WL)** **-Writing for scientific practices (WCP)** **-Writing for professional practices (WPP)** **-Writing for Writing Research (WWR)** **-Senior thesis writing (STW)** **-Reading for learning (RL)**	a) Writing to learn (WL)	**Case # 13: Page 1** *Esta ponencia tiene como propósito analizar la orientación y la evaluación de la escritura en una asignatura denominada Procesos de Ingeniería de Software y su incidencia en el aprendizaje de los contenidos por parte de los estudiantes. La investigación se apoya teóricamente en los fundamentos de la perspectiva de Alfabetización Académica y de la Escritura a través del Currículo. El diseño de las tareas de escritura corresponde a un trabajo colaborativo entre el docente de la asignatura, perteneciente al programa de Ingeniería de Sistemas y Computación, y una docente de escritura académica. Se realizó un estudio de caso. La información se recolectó a partir de distintas fuentes: encuestas a estudiantes al inicio*	**Case # 13: Page 1** This paper aims to analyze on writing guidance and assessment offered in a course titled "Software Engineering Processes" and its impact in students for learning content knowledge. The research relies on theoretical frameworks on Academic Literacy and Writing Across the Curriculum. Writing assignments were designed collaboratively between the instructor of the course and a writing instructor. A case study was conducted based on this experience. The information was collected from different sources: surveys from the students at the beginning and end of the semester, discussion group with the students; a depth interview with the instructor of the course; registration logs of team work meetings between both of the instructors; and textual and content analysis of writing guidelines and evaluation rubrics, and students'

		y al final del semestre, grupo de discusión con estudiantes; entrevista a profundidad con el docente; registro en bitácoras de los encuentros entre profesores; revisión documental de las consignas y rúbricas de evaluación construidas por los profesores y de los borradores y versiones finales de los trabajos escritos entregados por los estudiantes. En los resultados se destacan como elementos influyentes en el proceso de aprendizaje las orientaciones del profesor y las rúbricas de evaluación de los trabajos escritos, las realimentaciones y asesorías del docente del curso, la asignación de tareas de escritura con propósitos específicos y con situaciones comunicativas particulares, así como la posibilidad de hacer planeaciones y reescritura de los textos. El trabajo colaborativo entre profesores aparece como una posibilidad de potenciar la función epistémica de la escritura en las asignaturas. Este tipo de trabajo favorece, además del aprendizaje de contenidos disciplinares, el desarrollo de las competencias escriturales de los estudiantes y cambios en las prácticas pedagógicas de los mismos docentes.	productions. The results show as influential elements in the learning process: instructors' guidelines, evaluation rubrics, instructor's feedback, student-teacher conferences, assigning writing tasks with specific purposes, as well as opportunities to write drafts and present progress. The collaborative work between instructors it is a possibility to strengthen the epistemic function of writing to learn in subject matters. This type of team work not only helps in learning disciplinary content knowledge, but also enhances writing competencies of students and fosters changes of pedagogical practices of instructors.
	b) Writing for scientific practices (WCP)	**Case # 10: Page 10-11** *4. CONCLUSIONES Y DISCUSIÓN La metodología que acostumbraban los estudiantes a seguir en las prácticas de laboratorio no fue obstáculo para la acogida de la nueva propuesta; por el contrario, mostraron un alto grado de interés por la manera como se desarrollaban múltiples competencias en torno a las mismas actividades. Mediante una encuesta aplicada al finalizar el curso se pudo observar que el 75% de ellos vieron a la integración de procesos de lectura y escritura en su curso como una oportunidad para el desarrollo de estas competencias para su ejercicio profesional y aportar en los campos de su saber científico. El 50% de los estudiantes consideran que el ejercicio les ayuda a aprender y reflexionar sobre el uso del lenguaje escrito, mientras el 25% de ellos consideran que les*	**Case # 10: Page 10-11** 4. CONCLUSIONS AND DISCUSSION The methodology students are used to follow in the laboratory practices was not an obstacle for the receptiveness of this new proposal. On the contrary, they showed a high interest for how several competences were developed along with the activities. A survey applied at the end of the course showed that 75% of them could see the integration of the reading and writing processes within their course as an opportunity to develop these competences for their professional growth and to enrich their scientific knowledge. Also, 50 % of the students believe this practice helps them to learn and reflect about written language and 25% of them believe it assures the construction of spaces for discussion in academic settings. All of this represents the strength for the next phase of production in which the best of cognitive and experiential fortresses of students will be made, in order to publish articles in journals and

		contribuye para generar espacios de participación en escenarios académicos. Esto constituye una fortaleza para una siguiente fase de producción, en la que se exploten las bondades cognitivas y experienciales de los aprendices, de manera que se publiquen artículos en revistas y eventos técnico-científicos.	technic-scientific events.
	c) Writing for professional practices (WPP)	**Case # 21: Page 2** 1. INTRODUCCIÓN (…) En el campo de los estudios del discurso especializado, preocupados por la enseñanza, en Argentina se ha priorizado el estudio de los géneros académico-científicos, mientras que los géneros profesionales han recibido menor atención, posiblemente, por la dificultad que implica acceder a ellos debido a la confidencialidad de los datos que se comunican en los textos que circulan dentro de las organizaciones. Sin embargo, en el ámbito hispano han comenzado a desarrollarse recientemente algunas investigaciones sobre estos géneros (entre otros, Cassany y López, 2010 [3]; Montolío, 2007 [4], Parodi, 2010 [5]) que constituyen un importante aporte para el diseño de propuestas didácticas. Siguiendo esta línea incipiente, en el Instituto de Industria de la Universidad Nacional de General Sarmiento (UNGS), se está desarrollando una investigación que busca identificar los principales géneros del ámbito empresarial para aportar insumos para los diseños de las distintas materias del ciclo específico de las ingenierías (P # 2)	**Case # 21: Page 2** 1. INTRODUCTION (…) In the field of specialized discourse studies and with a particular interest for teaching, Argentina has prioritized the study of the academic-scientific area, while the professional ones have been underrated maybe because it is very difficult to access to the confidential data communicated in the texts spread among the organizations. Nonetheless, in the Hispanic context (Cassany & López, 2010 [3]; Montolío, 2007 [4], Parodi, 2010 [5], et al.) some investigations about these areas have been developed and this represents a great step for didactic proposals design. In this same emerging line, the Industry Institute of the General Sarmiento National University (UNGS) is now developing a research that looks for the identification of the principal genres in the business field, so to inform curriculum designs of the different subjects in the field of engineering (P # 2).
	d) Writing for Writing Research (WWR)	**Case # 11: Page 2** ***INTRODUCCIÓN*** *El Grupo de Apoyo para la Lectura y la Escritura en la Universidad del Valle surge como una propuesta piloto, para asesorar a los estudiantes de las distintas áreas en sus procesos de lectura y escritura, especialmente para apoyar algunos grupos cuyos docentes son participantes del diplomado para La lectura y la escritura en*	**Case # 11: Page 2** INTRODUCTION The Reading and Writing Support Group of the University of Valle (Univalle) was born as an experimental/pilot proposal to guide students of the different areas in the reading and writing process, especially to support some groups whose teachers participate in the *Reading and Writing in the College Classroom* Certification Program. This program is offered by the Vice-

el aula universitaria; diplomado que ofrece la Vicerrectoría Académica de la Universidad del Valle en el marco del programa de Cualificación docente. El Grupo de Apoyo está conformado por estudiantes de diferentes carreras como: Licenciatura en Lenguas Extranjeras Inglés - Francés, Ingeniería Civil, Enfermería, entre otros.

Este grupo de apoyo, hace parte de los nodos de la REDLEES Univalle y es coordinado y apoyado por el Grupo de Investigación Leer, Escribir y Pensar perteneciente a la Escuela de Ciencias del Lenguaje; este grupo de investigación se ha encargado de una serie de acciones encaminadas al mejoramiento de los procesos de lectura y escritura en la educación superior a través de sus investigaciones en el aula y de diferentes propuestas Académicas en la Universidad.

Los profesores que hacían parte del diplomado, debían llevar a cabo un proyecto de inclusión de lectura y escritura en sus asignaturas como requerimiento para su formación en el diplomado. En ese sentido, el objetivo del grupo de apoyo era ofrecer una asesoría, a los estudiantes que presentaran dificultades en cuanto a la comprensión de las consignas; la redacción y estructura de los trabajos, lo que comprende faltas de cohesión y coherencia; la búsqueda y selección de información; y la composición de textos como: el resumen, la reseña y el ensayo.

Con el propósito de adoptar una buena organización, desde los comienzos del grupo, se conformaron sub-grupos interdisciplinarios que se establecieron en distintas facultades de la universidad; de esta manera, se ofrecería una mejor atención a los estudiantes, ya que en el caso de ingenierías, por ejemplo, el estudiante estaría asesorado tanto por un monitor de humanidades como por dos de ingenierías. Por otra parte, se acordó registrar las sesiones de asesorías en diarios de campo grupales e individuales de modo que permitiera un proceso de

Rectory of the University of Valle in the Teacher Qualification framework. Students of different majors such as Foreign Languages Degree (English French), Civil Engineering, Nursing and others make part of the Support Group.

This support group makes part of the REDLEES Univalle and it is coordinated and supported by the *Read, Write and Think* Research Group of the Language Sciences School. This research group has been in charge of implementing some improvement plans for the reading and writing processes in college level, through classroom researches and different academic proposals in the University.

Teachers who made part of the certification program had to develop a project of reading and writing inclusion in their courses as a requirement for their learning process. In this way, the support group objective was to offer a tutorship to the students who show difficulties with composition and structure in written works, and in understanding the instructions. These difficulties are the result of a lack of cohesion and coherence, of information research and selection, and the exercise in composition of texts such as summaries, reviews and essays.

From the very beginning of the group, some interdisciplinary groups were formed in different departments of the university in order to adopt a suitable organization. Like this, a better assistance would be offered to the students, since in engineering cases for example, the students would be assisted by both a humanities monitor and two from the same field. On the other hand, the tutorship sessions were agreed to be registered in groups and individual field journals so to permit a process of reflection, evaluation and improvement from the support group.

		reflexión, evaluación y mejoramiento por parte del grupo de apoyo.	
	e) Senior thesis writing (STW)	**Case # 14: Page 12** **Abstract** The following paper presents a contribution to the pursuit of difficulties when writing higher-education-level reports. The study is based on both theoretical and empirical research involving students of engineering colleges from different universities in Bogotá D.C. Firstly, theoretical background is made explicit, followed by a focus on the methodology and a brief conclusions section. Finally, a set of classroom activities intended to help students overcome writing difficulties is proposed.	**Case # 14: Page 12** The original case was written in English
	f) Reading for learning (RL)	**Case # 19: Page 1-2** **Abstract** From strictly linguistic studies, the characterization of multisemiotic written specialized texts has been scarce or almost null. Not many corpus-based studies focus on the description of graphs, tables, and diagrams, as well as their layouts, as part of academic texts. The objective of this study is to identify, describe and quantify the occurrence of (multi)semiotic artifacts which are present in a sample of texts (1.043) belonging to the PUCV-2010 Academic Corpus. The corpus was collected in twelve PhD programmes in six Chilean universities and comprises all the documents students are given to read during their formal curricula, with the exception of those included in the final doctoral research (3,160 written texts, which are distributed among Physics, Chemistry, Biotechnology, History, Literature, and Linguistics). As part of the results, nine artifacts were identified and defined, based on the distinction of four semiotic interacting systems: verbal, graphical, mathematical, and typographical. Interesting differences are detected between Basic Sciences (BS) and Social Sciences and	**Case # 19: Page 1-2** The original case was written in English

		Humanities (SS&H), due to the prototypical type of artifacts and also considering the quantification of their occurrence across disciplines.	
i) The analysis of the publications also explored what might count as “genre”.	a) an individual textual and linguistic entity	**Case # 21: Page 2** ***Introducción*** *(...) En este trabajo, presentamos un diseño didáctico que articula las tareas de investigación sobre los textos profesionales con los contenidos disciplinares a partir de la enseñanza de un género profesional. Concretamente, se trata de una experiencia llevada a cabo en la materia Elementos de Economía para Ingenieros de una carrera de ingeniería en la que se aborda la enseñanza explícita de un género profesional, la memoria anual, en relación con los contenidos de las distintas unidades del programa de la asignatura. El objetivo perseguido fue el de promover el acercamiento del estudiante al ámbito profesional, a través de los juegos de rol tanto en forma escrita como oral.* *A continuación, se describe brevemente el marco del programa en el que se inscribe la experiencia que aquí comunicamos; luego, se presenta la materia en la que se llevó a cabo; seguidamente, se detalla el encuadre metodológico y la propuesta desarrollada; finalmente, se esbozan algunas conclusiones (P # 3).*	**Case # 21: Page 2** **Introduction** (…) In this research work we present a didactic design that articulates research work about professional writings with the disciplinary contents based on the teaching of a professional genre. More specifically, it is about an experience that took place in the Economy Elements for Engineers course of an engineering program in which the specific teaching of a professional genre and the yearly memory are addressed in relation with other contents of the course program different unties. The main goal was to promote the approaching of the student to the professional field, through role play in written and oral format. Below, the program framework is briefly described presenting the experience we want to communicate, then there is the course description; afterwards, the methodology and the developed proposal are detailed; finally, some conclusions are drawn (P # 3).
	b) as a group of linguistic, textual, and/or rhetorical patterns of language use that has been called "genre families“ or “genre repertoires	**Case # 5: Page 7-8** *Luego de ello, se diseñaron e implementaron diversas acciones en el marco de las asignaturas mencionadas, algunas de las cuales fueron:* *1. El informe semanal sobre la resolución de tres problemas que incluye una actividad metacognitiva.* *2. Trabajos de Laboratorio de Computación que incorporan aspectos interdisciplinarios.* *3. La tutoría de pares en las clases prácticas.* *1. El «informe semanal» sobre la resolución de tres problemas que incluye una actividad metacognitiva:* *La actividad consiste en la realización semanal de un trabajo grupal a partir del cual se elabora un informe. Cada grupo de tres integrantes*	**Case # 5: Page 7-8** After this, different actions were designed in the courses framework mentioned before. Some of these were: 1. The weekly report about the resolution of three problems that includes a metacognitive activity. 2. Computer Laboratory works involving interdisciplinary aspects. 3. Peer tutorship in practice classes. 1. The “weekly report” about the resolution of three problems that includes a metacognitive activity: The activity consists in the weekly development of a group work that serves as the starting point for building up report. Each group of three members

	resuelve tres problemas asignados por el profesor. En el informe grupal se detalla no sólo la información que se utilizó, los conceptos requeridos, métodos seleccionados, la justificación de la selección realizada, la descripción de los algoritmos utilizados, los resultados y conclusiones a los cuales arribó el grupo sino que se solicita que reflexionen sobre lo realizado y describan las dificultades encontradas. Con el objetivo de facilitar esta actividad los docentes proponen un cuestionario que cada grupo responde al final de cada informe. Este listado de preguntas ha sufrido modificaciones a lo largo del proceso de I-A, a partir de las experiencias realizadas. *A modo de síntesis se exponen algunas de las preguntas elaboradas y las diferentes categorías en las cuales se las ha clasificado, según el objetivo de las mismas:* *• Visualizar la interrelación de conceptos: ¿Qué conceptos nuevos o propiedades usé?, ¿Qué conceptos de otros cursos apliqué?, ¿Qué nuevo problema puedo resolver con los conceptos de esta unidad que antes no podía?* *• Observar el propio proceso: ¿Qué estrategias usé para comprender el enunciado de cada problema?, ¿Cuáles para diagramar el camino hacia la solución? ¿Encontré dificultades? ¿Cuáles?, ¿Cómo intenté solucionarlas?* *• Autoevaluar el procedimiento de resolución: ¿Repasé los conceptos teóricos correspondientes a cursos previos?, ¿Realicé algún diagrama que explique las sucesivas etapas del proceso de resolución?, ¿Hice una justificación teórica de cada paso realizado?, ¿Verifiqué los resultados intermedios?, ¿Discutí métodos alternativos para alguna etapa del proceso o del procedimiento general?* *• Detectar dudas: ¿Comprendí los conceptos que usé? ¿Pude aplicarlos? ¿Qué dudas quedan? ¿En qué tema necesito una nueva explicación del docente?*	solves three problems assigned by the teacher. In the group report the next items must be detailed: the used information, the required concepts, chosen methods, the justification of the choice, the description of the used algorithms, the results and conclusions found by the group. Moreover, this report must contain a reflection on the work made and other on the difficulties that appeared throughout the process. Also, the teachers propose a group questionnaire at the end of each report, in order to facilitate tis activity. This questions list has suffered some changes all along the process of I-A, from the lived experiences. As a synthesis, down below there is a presentation of some of the questions and the categories they are classified into according to their objectives: • View of the concepts interrelation: Which new concepts or properties did I use? What concepts did I apply from other courses? Which new problem can I solve with the help of these unit concepts that I couldn't do before? • Observation of the own process: Which strategies did I use to understand each problem statement? What strategies did I use to draw the path towards the resolution? Did I find difficulties and which? How did I try to solve them? • Self-evaluation of the resolution procedure: Did I study the theoretical concepts from previous courses? Did I draw any diagram that explains the consequent phases of the resolution process? Did I do a theoretical justification of every step I took? Did I verify the midterm results? Did I discuss alternative methods for any process phase or the general procedure? • Detection of doubts: Did I understand the

			concepts I used? Can I apply them? What doubts were not solved? In which topic do I need a new teacher explanation?
	c) as language usage and circulation by different participants within discourse communities and actual institutions (genre systems)	**Case # 10: Page 7** ***2. ESTRATEGIAS METODOLÓGICAS*** *La intervención se llevó a cabo implementando una metodología constructivista, con base en la línea del aprendizaje activo centrado en estudiantes. En este contexto, se identificaron cuatro etapas a lo largo del curso: en la primera, el profesor es el entrenador del estudiante, que como ente dependiente recibe retroalimentación inmediata en cada una de las consignas planteadas; así, el recurso de la cátedra es de carácter informativo. En la segunda etapa, el estudiante se muestra más interesado y el profesor es su motivador, tornándose en una cátedra más inspiradora basada en metas específicas. Como tercera medida, el profesor es un facilitador de medios de aprendizaje, mientras el estudiante se involucra en el contexto de trabajo en equipo y pone a prueba su capacidad discursiva a través de seminarios. En la etapa final, el estudiante es auto-dirigido y el profesor pasa a una instancia de consultor.* *En cada una de las etapas arriba mencionadas se utilizaron alternadamente lecturas previas a la clase, tareas, estudios de caso, micro-proyectos, aprendizaje cooperativo con base en el trabajo en equipo y generación de preguntas conceptuales. Para garantizar una experiencia concreta, se plantearon proyectos integradores, mientras que paralelamente se realizaba una observación reflexiva basada en diarios y notas de laboratorio. La experimentación activa es fundamental en este proceso y se llevó a cabo a través de tutoriales, simulaciones y prácticas de laboratorio. El conjunto de experiencias y productos, obtenidos durante el proceso de aprendizaje, se compilaron en textos expositivos, de tipo informe de laboratorio, y un*	**Case # 10: Page 7** 1. METHODOLOGICAL STRATEGIES The intervention was made implementing a constructivist methodology based in the line of active learning focused on students. In this context, four phases were identified all along the process: in the first one the teacher is the student trainer and the student is the dependent being who receives immediate feedback in each of the statement, in other words, the resource of the teaching is merely informative. In the second phase, the student shows more interest and the teacher is the motivator who takes a professorship more inspiring and based on specific goals. As a third measure, the teacher is a means of learning facilitator, while the student is involved in the context of group work y tests his discourse ability through seminars. In the final phase, the student is self-directed and the teacher becomes a consultant. In each phase before mentioned the tools used were previous class readings, homework, case studies, micro-projects, cooperative learning based on group work and the construction of conceptual questions. Integrating projects were suggested to guarantee a concrete experience, while at the same time a reflection observation was made based on the diaries and laboratory notes. The active experimentation is crucial in this process and it was developed through tutorships, simulations and laboratory practices. The ensemble of experiences and products obtained during the learning process was compiled in expository texts such as laboratory reports, and an experiences book. Finally, each group of students wrote a scientific article that must be put under a process of local revision y must be postulated to national and international magazines according to the final evaluation.

	libro de experiencias. Finalmente, cada grupo de estudiantes redactó un artículo de carácter científico, que deberá ser sometido en un proceso de revisión local y postulado a revistas nacionales o internacionales, según valoración final.	

Appendix 3

Examples of the grounded categories with original fragments of the publications analyzed

Category in the section of conclusions					
Writing for learning is associated with engagement (WLE)					
Examples of the sample					
# of the sample	**Title**	**Country**	**Year**	**Original fragment**	**Interpretation into English**
5	Mejorar la enseñanza y el aprendizaje de la Matemática en Bioingeniería: Un desafío asumido desde la investigación-acción	Argentina	2012	*Con el objetivo de evaluar la percepción de los estudiantes respecto de la realización del informe semanal, se elaboró una encuesta que fue tomada a los alumnos de los cursos 2008, 2009 y 2010. Las preguntas y sus correspondientes resultados se muestran en la Tabla Nº 3. Se observa que en promedio el 85% de los alumnos consideraron que la experiencia resultó útil y necesaria para un mejor desempeño ya que ayudó a comprender conceptos y corregir errores; el 15% expresó que no fue positiva fundamentalmente por no respetar el ritmo individual, por demandar demasiado tiempo.*	A survey was designed and implemented to the students in the courses 2008, 2009 and 2010, with the purpose of evaluating their perception of the weekly report realization. The questions and their results are shown in Exhibit N° 3. It is shown that in average the 85% of the students consider the experience is helpful and necessary for a better performance, since it helped them to understand concepts and correct mistakes. On the other hand, the 15% of the students said the experience was not positive, most of all for the lack of respect in the individual rhythm and for being too demanding in terms of time.
10	Integración de la lectura y la escritura en el curso de laboratorio de dispositivos electrónicos de ingeniería electrónica	Colombia	2014	*El 50% de los estudiantes consideran que el ejercicio les ayuda a aprender y reflexionar sobre el uso del lenguaje escrito, mientras el 25% de ellos consideran que les contribuye para generar espacios de participación en escenarios académicos.*	Also, 50% of the students consider that this exercise helps them to reflect about the written language use, while the 25% of them consider it contributes to the construction of participation spaces in academic settings.

Category in the section of discussion (limitations)					
Amount of students (AS)					
Examples of the sample					
# of the sample	**Title**	**Country**	**Year**	**Original fragment**	**Interpretation into English**
2	Creando un espacio de investigación educativa en una facultad de ingeniería	Argentina	2009	*En cuanto a los aspectos negativos o dificultades en la implementación: "resulta difícil distribuir el tiempo entre el control del trabajo individual y la discusión grupal para explicar temas en los que se detectan fallas generalizadas en el grupo". "El número de alumnos elevado por comisión impide que se pueda hacer un seguimiento más personalizado".*	Regarding the negative aspects and difficulties in the implementation, "it is difficult to distribute the time between the control of individual work and group discussion to explain the subjects in which generalized errors in the group are detected". "The number of students raised to the commission impedes a more personalized monitoring".

Category in the section of discussion (implications)					
Designing teaching material disciplinary-oriented (DM)					
Examples of the sample					
# of the sample	**Title**	**Country**	**Year**	**Original fragment**	**Interpretation into English**
17	Academic and professional genre Variation across four disciplines: Exploring the pucv-2006 corpus of Written Spanish	Chile	2010	Research studies like the one described here also have pedagogical implications concerning: (a) the selection of written genres, (b) the elaboration of teaching materials, and (c) the preparation of language tests of various kinds, such as the assessment of disciplinary contents and of specialized discourse comprehension.	The original case was written in English
20	Alfabetización profesional durante la carrera universitaria: entre la universidad y la empresa	Argentina	2015	*En consecuencia, se hace evidente el importante valor que tiene continuar avanzando en el relevamiento de lo que ocurre en el mundo profesional para identificar y describir los principales géneros de este ámbito para el diseño de propuestas didácticas a ser incluidas en el trayecto formativo de nuestros ingenieros.*	Consequently, it is evident that it is necessary to continue advancing in the study of what occurs in the professional field to identify and describe the principal genres of this area for the didactic proposals design that could be included in the learning process of our engineers.

Appendix 4
Occurrences of the publications research-oriented

# of the case	Title	Interpretation into English	Country	Year	Type of genre of the publication	Research orientated (RO)
17	Academic and professional genre Variation across four disciplines: Exploring the pucv-2006 corpus of Written Spanish	The original case was written in English	Chile	2010	JA	1
18	*La organización retórica del género Manual A través de cuatro disciplinas: ¿cómo se comunica y difunde LA ciencia en diferentes Contextos universitarios?*	The rhetoric organization of the Manual genre through four disciplines: how is science communicated and spread in the different university contexts?	Chile	2010	JA	1
19	Multisemiosis and corpus linguistics: multisemiotic artifacts in the texts of six disciplines in the academic pucv-2010 corpus	The original case was written in English	Chile	2010	JA	1
14	*Dificultades de la escritura de informes de investigación formativa en la educación superior en facultades de Ingeniería*	Difficulties in writing formative research reports at university level in engineering	Colombia	2012	JA	1
7	*Experiencias de formación y de inserción laboral de ingenieros: las voces de los protagonistas desde una investigación biográfica*	Learning processes and professional insertion experiences of engineers: the voices of the protagonists from a biographic research	Argentina	2013	JA	1
9	*Desarrollo de competencias comunicativas en la formación del ingeniero: una propuesta interdisciplinaria*	Development of communicative competences in the engineer learning process: an interdisciplinary proposal	Argentina	2013	JA	1
20	*Alfabetización profesional durante la carrera universitaria: entre la universidad y la empresa*	Professional literacy during the university career: between the university and the enterprise	Argentina	2015	JA	1
22	*Géneros y formación ingenieril: de la universidad a la industria*	Genres and engineering education: from university to the industry	Argentina	2015	JA	1
Total						**8**

Appendix 5
Occurrences of the publications pedagogically-oriented

# of the case	Title	Interpretation into English	Country	Year	Type of publication genre	Pedagogical oriented (PO)
2	*Creando un espacio de investigación educativa en una facultad de ingeniería*	Creating an educational research space in an engineering department	Argentina	2009	OC	1
6	Early error detection: an action-research experience teaching vector calculus	The original case was written in English	Argentina	2013	JA	1
8	*Desarrollo de habilidades de lectura y escritura en la trayectoria académica del ingeniero: la experiencia de un programa desafiante e innovador*	Reading and writing abilities development in the academic process of the engineer: the experience of a challenging and innovative program	Argentina	2012	JA	1
10	*Integración de la lectura y la escritura en el curso de laboratorio de dispositivos electrónicos de ingeniería electrónica*	Integration of reading and writing in the laboratory course of electronic devices in Electronic Engineering	Colombia	2014	OC	1
11	*El cambio de concepción sobre escritura del asesorado tras la revisión entre pares: una experiencia del grupo de apoyo para la lectura y escritura en la facultad de ingeniería*	The change in the writing conception of the advised after peer revision: an experience of the support group for reading and writing in the engineering faculty	Colombia	2014	OC	1
12	*Incidencia del grupo de apoyo para la lectura y escritura en la construcción de conocimiento de estudiantes de ingeniería*	The influence of the support group for reading and writing in the knowledge construction for engineering students	Colombia	2014	OC	1
21	*Géneros profesionales en la formación del ingeniero*	Professional genres in the engineer learning process	Argentina	2013	OC	1
Total						**7**

Appendix 6
Occurrences of the publications that report research on pedagogical experiences

# of the case	Title	Interpretation into English	Country	Year	Type of publication genre	Research on Pedagogical experiences (RPE)
3	Interdisciplinarity: perspectives for the design of Didactic strategies in engineering	The original case was written in English	Argentina	2010	OC	1
4	Action Research: A way to generate new approaches to teaching mathematics in Bioengineering	The original case was written in English	Argentina	2010	OC	1
1	*Los resúmenes como estrategia de aprendizaje*	Summaries as a learning strategy	Colombia	2012	JA	1
5	*Mejorar la enseñanza y el aprendizaje de la Matemática en Bioingeniería: Un desafío asumido desde la investigación-acción*	Improvement of Mathematics teaching and learning in Bioengineering: a challenge assumed from action research	Argentina	2012	JA	1
13	*Escribir para aprender y comunicar en la asignatura Procesos de Ingeniería de Software. Trabajo colaborativo entre docentes de lengua y docentes de las disciplinas*	Writing as a means of learning and communication in the Engineering Software Processes course. Collaborative work between language teachers and those of other disciplines	Colombia	2014	OC	1
15	*Elaboración de resúmenes, una estrategia de estudio en ingeniería*	Writing summaries, a learning strategy in engineering	Colombia	2014	OC	1
16	*Orientación y evaluación de la escritura en asignaturas disciplinares. Experiencia de trabajo colaborativo docente*	Orientation and evaluation of writing in disciplinary subjects. A teacher collaborative work experience	Colombia	2015	OC	1
Total						**7**

Appendix 7

Examples of original fragments of the cases of the sample institutionally-oriented and interdisciplinary-oriented

Categories	Examples of original fragments of the cases of the sample	Interpretation into English
Institutionalization	**Case # 20: Page 2** **Abstract** Writing practices and the teaching of writing in the university level is a growing research area in which scholars of different disciplines work. This paper presents some partial results of an ongoing research project about writing practices in the Industrial Engineering field. As part of the activities of an institutional program for teaching academic and professional literacy across the university curriculum (PRODEAC) developed at Universidad Nacional de General Sarmiento (UNGS), we surveyed a group of engineers in order to analyze the genres employed in professional settings. Secondly, we asked students working in different companies to tell us which genres they had already used a) at work and b) in the university assignments. In contrast with the findings of previous research work carried out in Spain and Chile, we have found out that students in different courses produced 20 of the 33 genres required in the companies. We have also identified the genres we need to describe and include them in the pedagogical designs of the subjects.	**Case # 20: Page 2** The original case was written in English
Interdisciplinarity	**Case # 1: Page 1-2** **Summary** Writing as a Learning Strategy This article presents the findings of an interdisciplinary study on summary writing as a learning strategy which was carried out by a language professor and an engineering professor in the Materials Resistance course, offered to Universidad del Valle engineering students. The ultimate purpose in using this strategy was to raise students' consciousness about the key role of writing in their learning process. Unlike traditional summary writing, these ones were not written for the professor for him to assess whether the students had reviewed course contents. Instead, summaries provided the students with an opportunity to monitor their own learning process and express what they had learned in a written format. A portion of the class session was devoted to check students' production, so that they could assess self-progress. A quantitative-qualitative methodology was used to analyze the experience which was based on data collected by means of a survey and records of class interventions. This analysis shows that introducing students to summary writing as a meta-cognitive strategy had a positive influence on their learning process.	**Case # 1: Page 1-2** The original case was written in English

Appendix 8
Genres mentioned as individual entities in the initiatives and studies

# of the case	Title	Interpretation into English	Country	Year	Individual genres
2	*Creando un espacio de investigación educativa en una facultad de ingeniería*	Creating an educational research space in an engineering department	Argentina	2009	metacognitive writing to solve mathematical problems
4	Action Research: A way to generate new approaches to teaching mathematics in Bioengineering	The original case was written in English	Argentina	2010	mathematical texts
18	*La organización retórica del género Manual A través de cuatro disciplinas: ¿cómo se comunica y difunde LA ciencia en diferentes Contextos universitarios?*	The rhetoric organization of the Manual genre through four disciplines: how is science communicated and spread in the different university contexts?	Chile	2010	textbooks
1	*Los resúmenes como estrategia de aprendizaje*	Summaries as a learning strategy	Colombia	2012	summaries
5	*Mejorar la enseñanza y el aprendizaje de la Matemática en Bioingeniería: Un desafío asumido desde la investigación-acción*	Improvement of Mathematics teaching and learning in Bioengineering: a challenge assumed from action research	Argentina	2012	mathematical texts
14	*Dificultades de la escritura de informes de investigación formativa en la educación superior en facultades de Ingeniería*	Difficulties in writing formative research reports at university level in engineering	Colombia	2012	Reports of formative research experiences
6	Early error detection: an action-research experience teaching vector calculus	The original case was written in English	Argentina	2013	weekly reports
9	*Desarrollo de competencias comunicativas en la formación del ingeniero: una propuesta interdisciplinaria*	Development of communicative competences in the engineer learning process: an interdisciplinary proposal	Argentina	2013	standardized operating procedure
21	*Géneros profesionales en la formación del ingeniero*	Professional genres in the engineer learning process	Argentina	2013	Annual report
11	*El cambio de concepción sobre escritura del asesorado tras la revisión entre pares: una experiencia del grupo de apoyo para la lectura y escritura en la facultad de ingeniería*	The change in the writing conception of the advised after peer revision: an experience of the support group for reading and writing in the engineering faculty	Colombia	2014	pedagogic journal
13	*Escribir para aprender y comunicar en la asignatura Procesos de Ingeniería de Software. Trabajo colaborativo entre docentes de lengua y docentes de las*	Writing as a means of learning and communication in the Engineering Software Processes course. Collaborative work between language	Colombia	2014	Writing assignments

	disciplinas	teachers and those of other disciplines			
15	*Elaboración de resúmenes, una estrategia de estudio en ingeniería*	Writing summaries, a learning strategy in engineering	Colombia	2014	summaries
16	*Orientación y evaluación de la escritura en asignaturas disciplinares. Experiencia de trabajo colaborativo docente*	Orientation and evaluation of writing in disciplinary subjects. A teacher collaborative work experience	Colombia	2015	Writing assignments
22	*Géneros y formación ingenieril: de la universidad a la industria*	Genres and engineering education: from university to the industry	Argentina	2015	Writing assignments

Appendix 9
Occurrences of the topics in the conclusion sections

Topics of the conclusions	Occurrences
Writing to learn is correlating with approving the classes (WLPC)	**7**
Writing to learn is associated with engagement (WLE)	**7**
Interdisciplinary work is an opportunity (IO)	**6**
Genre studies is a necessary approach (GS)	**3**
Professional genres are taught in college levels (PG)	**2**
Writing assignments increase the use of learning sources other than instructors (RS)	**1**
Textbooks reflect variation of disciplinary pedagogic practices (TD)	**1**
Scientific texts are multisemiotic (MS)	**1**
Professional genres and academic genres do no coexist in corpora (NC)	**1**
Peer review as a learning opportunity for diverse student population (PRO)	**1**
Interdisciplinary work is possible with chairs of departments (IC)	**1**
Interdisciplinary work is challenging (IW)	**1**
Instructors in senior years can provide samples of professional situations (SIPS)	**1**
Articulating genre conventions, writing situations and artifacts affects positively on learning (GCSL)	**1**

Appendix 10
Occurrences of types of publications that include as conclusion "Writing to learn is correlating with approving the classes (WLPC)"

#	Title	Interpretation into English	Country	Year	Research orientated (RO)	Research on Pedagogical experiences (RPE)	Pedagogically-orientated (PO)
1	*Los resúmenes como estrategia de aprendizaje*	Summaries as a learning strategy	Colombia	2012	0	1	0
3	Interdisciplinarity : perspectives for the design of Didactic strategies in engineering	The original case was written in English	Argentina	2010	0	0	1
4	Action Research: A way to generate new approaches to teaching mathematics in Bioengineering	The original case was written in English	Argentina	2010	0	0	1
5	*Mejorar la enseñanza y el aprendizaje de la Matemática en Bioingeniería: Un desafío asumido desde la investigación-acción*	Improvement of Mathematics teaching and learning in Bioengineering: a challenge assumed from action research	Argentina	2012	0	0	1
6	Early error detection: an action-research experience teaching vector calculus	The original case was written in English	Argentina	2013	0	0	1
13	*Escribir para aprender y comunicar en la asignatura Procesos de Ingeniería de Software. Trabajo colaborativo entre docentes de lengua y docentes de las disciplinas*	Writing as a means of learning and communication in the Engineering Software Processes course. Collaborative work between language teachers and those of other disciplines	Colombia	2014	0	1	0
15	*Elaboración de resúmenes, una estrategia de estudio en ingeniería*		Colombia	2014	0	1	0
	Total				0	3	4

Appendix 11

Occurrences of types of publications that include as conclusion "Interdisciplinary work is an opportunity (IO)"

#	Title	Interpretation into English	Country	Year	Research orientated (RO)	Research on Pedagogical experiences (RPE)	Pedagogically-orientated (PO)
4	Action Research: A way to generate new approaches to teaching mathematics in Bioengineering	The original case was written in English	Argentina	2010	0	0	1
8	*Desarrollo de habilidades de lectura y escritura en la trayectoria académica del ingeniero: la experiencia de un programa desafiante e innovador*	Reading and writing abilities development in the academic process of the engineer: the experience of a challenging and innovative program	Argentina	2012	0	0	1
11	*El cambio de concepción sobre escritura del asesorado tras la revisión entre pares: una experiencia del grupo de apoyo para la lectura y escritura en la facultad de ingeniería*	The change in the writing conception of the advised after peer revision: an experience of the support group for reading and writing in the engineering faculty	Colombia	2014	0	0	1
13	*Escribir para aprender y comunicar en la asignatura Procesos de Ingeniería de Software. Trabajo colaborativo entre docentes de lengua y docentes de las disciplinas*	Writing as a means of learning and communication in the Engineering Software Processes course. Collaborative work between language teachers and those of other disciplines	Colombia	2014	0	1	0
16	*Orientación y evaluación de la escritura en asignaturas disciplinares. Experiencia de trabajo colaborativo docente*	Orientation and evaluation of writing in disciplinary subjects. A teacher collaborative work experience	Colombia	2015	0	1	0
20	*Alfabetización profesional durante la carrera universitaria: entre la universidad y la empresa*	Professional literacy during the university career: between the university and the enterprise	Argentina	2015	1	0	0
	Total				1	2	3

Appendix 12
Occurrences of the topics on limitations of the initiatives/studies

Topics of the Limitations	Occurrences
Students did not develop audience awareness (AA)	**2**
Amount of students (AS)	**2**
Strong assumptions on mathematical identity in engineering (MA)	**1**
Teaching professional genres in classroom is artificial (PGA)	**1**
Lack of professional genre descriptions to design learning experiences (PGD)	**1**
Textbooks cannot be the only academic genre to read in higher education (TBR)	**1**
Time for interdisciplinary work (TI)	**1**
Student difficulties for team work (TW)	**1**
Students' complaints for demanding activities (SCD)	**1**

Appendix 13
Occurrences of the topics of the implications for further research and curriculum innovations

Topics of the implications	Occurrences
Designing teaching material disciplinary-oriented (DM)	**6**
Incorporating writing experiences across the curriculum (WAC)	**4**
Further research on professional genres (PG)	**4**
Incorporating clear prompts and carefully scaffolding (PD)	**3**
Bridging academic writing practices and professional writing practices (BP)	**3**
Further research on student writing development associated to the interdisciplinary initiative (WDS)	**2**
Further research on disciplinary pedagogical practices and rhetorical moves of textbooks (PPT)	**1**
Articulating genre conventions, writing situations, and artifacts (GCS)	**1**
Further research on textual multimodality of scientific texts and its psycholinguistic processing (MST)	**1**
Further action-research on the initiatives (AR)	**1**
Further research on faculty member development on genre awareness associated to interdisciplinary initiative (GAF)	**1**
Incorporating professionally-oriented tasks from freshman years (PTF)	**1**
Further interdisciplinary team teaching (ITT)	**1**

Appendix 14
Occurrences of types of publications that include as implication "Bridging academic writing practices and professional writing practices"

#	Title	Interpretation into English	Country	Year	Research orientated (RO)	Research on Pedagogical experiences (RPE)	Pedagogical orientated (PO)
17	Academic and professional genre Variation across four disciplines: Exploring the pucv-2006 corpus of Written Spanish	The original case was written in English	Chile	2010	1	0	0
20	*Alfabetización profesional durante la carrera universitaria: entre la universidad y la empresa*	Professional literacy during the university career: between the university and the enterprise	Argentina	2015	1	0	0
22	*Géneros y formación ingenieril: de la universidad a la industria*	*Genres and engineering education: from university to the industry*	Argentina	SP	1	0	0
	Total				3	0	0

II. Chapter 2. Agendas for Technical Communication in a Latin-American country

Abstract

Technical Communication is an interdisciplinary field to investigate and teach about production and circulation of scientific and engineering contents that has established in the context of a developed economy. In Latin America, there is no specific field equivalent to Technical Communication as developed in the U.S. Therefore, exploring what counts as expectations of engineering writing and communication in a developing economy contributes to contextualizing agendas for Technical Communication writing in a Latin-American country. This chapter thus reviews literature on technological innovation and economic growth in Latin America and chronologically analyzes online news on national engineering from the two oldest newspapers in a developing country, Colombia, with special attention to implications on learning writing, language, and communication. Such context is discussed within a literature review of the U.S. scholarship on Technical Communication to ultimately propose research agendas for a Latin-American country. The analysis reveals, among other issues, that engineers of developing economies might be exposed and "enculturated" under communicative practices of "price takers"[14], which may imply language practices undermining opportunities for negotiation and argumentation. This hypothesis might be further tested by conducting studies on communicative practices of business negotiations between Colombian and foreign entrepreneurs. This study also offers a list of business and research organizations/associations that might be interesting research sites in Colombia to explore technical communication practices, particularly those related to technology transfer (e.g. patent production and legalization) and public communication of science (especially, risk communication associated with natural resource-processing industries). These sites reflect current Colombian public interests in technology and innovation (e.g., the emphasis in the computer science subfield, and science-oriented reforms for elementary, secondary, and higher education to recruit more future engineers and non-traditional students).

A. Introduction

The field of Technical Communication in the U.S. has developed in interplay with economic changes, technological developments (especially computer and digital innovations), and the influence of science in society. Therefore, advancement of disciplines

14 "Price Taker" is an investor who makes orders that are not large enough to affect the price; when "price takers" make orders, they must accept the price offered by another investor. A "price taker" may be an individual or a (small) company. A "price taker" contrasts with a "price maker", which makes orders of

such as Engineering which has been powerful since the field generates scientific knowledge and designs products for the market that affect other communities in pursuing disciplinary and profit-oriented agendas.

The acceleration and specialization of jobs because of the influence of technological growth and innovation in the U.S. might explain the origin of the field called "Technical Communication" (Russell, 1991; Spilka, 2002). The explosion of knowledge production and expansion of U.S. higher education during and after the World War II fostered the spread of writing instruction associated with science and technical education. Furthermore, curriculum reforms between 1950 and 1980 in teaching sciences in the U.S. integrated language specialization with learning science. Such reforms included laboratory inquiry and discovery methods, from which students were encouraged to learn as scientists (Russell, 1991).

Since Technical Communication is an interdisciplinary field established in the context of a developed economy, exploring what counts as expectations of engineering writing and communication in a developing economy contributes to contextualizing agendas for Technical Communication writing in a Latin-American country.

The analysis of 22 publications (oral communications and journal articles) on Latin-American initiatives and studies in engineering writing and communication of Spanish Speaking countries shows that systematic endeavors (teaching and research) are recent in the region (since 2009), and there is a an emphasis on pedagogically-oriented publications (writing to learn[15]); thus, in Latin America there is no specific field equivalent to Technical Communication as developed in the U.S.

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sufficient quantity to affect the market price. Information taken from: Web. 3 July 2015. <http://financial-dictionary.thefreedictionary.com/Price Taker>.

15 Carter et al., (2007) cite Broadhead, 1999 (p. 19) to summarize two approaches: "writing to learn—i.e., writing as a means of acquiring information, understanding concepts, and appreciating significance in any

Within this context, this chapter suggests research agendas on Technical Communication for a developing country, Colombia. To do so, this study first reviews literature on technological innovation and economic growth in Latin America, and then chronologically analyzes online news on national engineering from the two oldest Colombian newspapers, with special attention to implications on learning writing, language, and communication. These two frameworks are discussed within a literature review of the U.S. scholarship on Technical Communication to propose research agendas for Colombia.

B. Literature review on Technological Innovation and Economic growth in Latin America in the 20th century

This section presents a literature review on technological and economic growth in Latin America, particularly reforms that have impacted relationships among industry, technology, scientific production, and higher education.

The science and technology (S&T) policy-making bodies in Brazil and Mexico were founded in the early 50s, followed by Argentina. By the early 70s, a significant number of countries —including the members of the Andean Pact[16] (Bolivia, Colombia, Ecuador, Peru, Venezuela, and Chile) and Cuba— had established some forms of systematic policy thinking on S&T policies (Vonortas, 2002).

Latin America entered a new phase of development since the early 1980s. Poor economic performance and pressure from international financial institutions urged most of the countries

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discipline . . . [versus] learning to write—i.e., acquiring the socially-mediated communication skills and genre knowledge appropriate to a specific discipline" (Broadhead, 1999, p. 19).

16 The Andean Pact (*Pacto Andino*) is a custom union comprised originally by Bolivia, Colombia, Ecuador, and Peru. The trade bloc came into existence by signing "The Cartagena Agreement" in 1969. Information taken from: ¿What is the Andean Pact?" *Banco De La República*. Banco Central De Colombia. Web. 28 Jan. 2016. <http://www.banrep.gov.co/en/node/23647>.

in the region to abandon protectionist economic policies and adopt reforms including economic liberalization, privatization, and deregulation (Vonortas, 2002).

Consequently, since 1980 the Latin-American industrial sector has changed patterns of production and specialization. There has been a shift in favor of non-tradable sectors such as telecommunication, energy, financial services as well as toward natural resource-processing industries that produce iron and steel, petrochemicals, nonferrous minerals, fishmeal, vegetable oil, pulp and paper. In addition, electronic, garment *maquiladoras* (assembly plants), and automobile producers have grown rapidly throughout this period in response to pragmatic and profitable industrial policies applied by local economy authorities (Katz, 2000).

Large domestically-owned conglomerates, as well as subsidiaries from transnational corporations (TNCs), have established modern and capital-intensive systems in the mentioned sectors. Apart from non-tradable goods and services, many of these new production facilities have become major exporters of industrial commodities to highly competitive world markets. However, Latin-American firms act in such markets as “price takers”[17]. Consequently, Latin-American firms act with little bargaining power and obtain low profits (Katz, 2000).

Furthermore, research and development (R&D) expenditures remain low in Latin America, ranging from approximately 1% of Gross domestic product (GDP) for Brazil, to 0.75% for Chile, 0.5% for Mexico, and 0.3% for Argentina. Further, funding is allocated primarily in public agencies and universities rather than in the private sector. Inducing the

17 “Price Taker” is an investor who makes orders that are not large enough to affect the price; when “price takers” make orders, they must accept the price offered by another investor. A “price taker” may be an individual or a (small) company. A “price taker” contrasts with a “price maker”, which makes orders of sufficient quantity to affect the market price. Information taken from: Web. 3 July 2015. <http://financial-dictionary.thefreedictionary.com/Price Taker>.

private sector, comprised of small and medium size enterprises (SMEs), to innovate has been an arduous task (Vonortas, 2002).

Following the debt crisis of the early and mid-80s, there has been a considerable reduction of the state involvement in technological development. Economic policies for all of the sectors are established by the market, comparative advantage, and profitability. Scientific and Technological (S&T) institutions have also been streamlined or eliminated, and any attempts to develop local technologies through public enterprises in telecommunications or informatics have ceased and the firms privatized. Additionally, intellectual property protection laws have been strengthened by expanding the scope of patents to previously excluded products, increasing their duration, and by introducing tougher penalizations (Vonortas, 2002).

Within this context, modernization in Latin America is undermined. However, dominant assumptions about modernization have been criticized by some scholars who complicate the way "modernization models" are seen: from Western Europe and North America toward the rest, from first modernizers to late modernizers, from industrial to less industrial, from superior cultures that encouraged entrepreneurship, technological innovation and economic achievement, to others that did not (López-Alves, 2011).

In this approach, the connection between Europe and Latin America, during and after colonization, became the key problematic factor to explain the lack of development and modernity in the region. As is well documented, colonialism made the region dependent, debt ridden, and vulnerable but most importantly with no industrial revolution undertaken; thus, Latin America's modernity has been hindered from the start. Accordingly, in these critical perspectives, the goal is to make visible local contributions to honor regional originality and, cultural and institutional innovation in postcolonial contexts (López-Alves, 2011).

Aligned with this approach, for instance, some Latin-American historians of science have embraced what is called "local approach" by creating historical accounts that become “less defensive”[18], analytically richer, and more firmly fixed on local dimensions of the rise of the science movement; in other words, generating accounts on technoscience that are necessarily embedded in the social, cultural, and intellectual contexts in which they are produced. Consequently, in this approach, historical analysis are more than descriptions of failures of the European science or the U.S. science in other localities primarily explained by the backwardness or deficiency in the target culture; alternatively, technoscience accounts must uncover the local intellectual and socio-economic interests in interplay with other structural aspects of the international science system that mostly favored the "West" and the "North” (Chambers & Gillespie, 2000).

This overview confirms that scientific knowledge and production in some Latin-American countries is underdeveloped with few funding opportunities from governments and bare attention from private corporations or industries. However, this exploratory literature review also shows that there is a call for cultural studies on Latin-American technoscience that not only honor local conditions but also complicates the interplay with international science systems that have historically favored the “West” and the “North”.

To better understand local exigencies at stake related to engineering with special focus on implications of learning writing, language, and communication, the next section presents a chronological analysis of online news in a developing country, Colombia, to contextualize public expectations that will be later articulated to conditions of technological innovation and economic growth in Latin America.

[18] Because of the tendency of Latin-American scholars is to approach the issue from dichotomic perspectives by attempting to distinguish center-periphery, science-technology, colonial-national science, dependent –

C. Chronological analysis of online news on national engineering

This section presents a chronological analysis of online news from the two oldest newspapers in Colombia. This analysis is useful to create accounts of public expectations regarding "engineering" and its relationship, if any, with higher education and expectations on learning writing, language, and communication. Later, this data will be triangulated with the literature review to propose research agendas for Technical Communication in Colombia.

The first portion of this section describes the samples that were created, and a second portion presents the analysis conducted by organizing four groups of results that describe:

a) presence of online news on Colombian engineering over time;

b) presence of engineering fields;

c) news with implications for higher education with special focus on learning writing, language, and communication; and,

d) associations and organizations mentioned in the news.

1. Sample creation

Quantitative and qualitative analyses were conducted of the digital news displayed by the websites of the two oldest Colombian newspapers: *El Tiempo* (1911) & *El Espectador* (1887).

The analysis of the news was conducted by creating four types of purposive samples:

1) Identifying the amount of online news that was displayed by searching under the tag "*ingeniería*" in both newspapers (engineering in Spanish). The search was conducted during March 2015, and the latest digital news that was related to the topic of this study (Colombian engineering and its relationships with higher education, learning

---

independent science, and basic –applied science.

writing, language, and communication) belonged to *El Espectador* and was published in January, 2nd 2015.

2) Titles and headlines of the news of sample # 1 were read to select only news related to Colombian issues (81 in total) and then created the following grounded categories regarding types of news:

   a) News on academic events;

   b) News on college programs and students' innovations;

   c) News on research grants;

   d) News on awards;

   e) News on technological innovation; and,

   f) News on international treaties and policies that impact in Colombia.

The final database of online news analyzed is presented in appendix 1. The news of sample 2 (81 in total) were also read to explore: i) the subfields in engineering mentioned in the news; ii) levels of education (professional level, undergraduate level, graduate level); and, iii) mentions related to computers, robots or machines, and labs.

3) Another qualitative reading was conducted of the news of the sample 2 to explore news (40 news in total) that deploy implications for i) higher education; ii) research on Higher Education, and/or iii) learning on writing, communication, or language in Higher Education.

4) Additionally, a database of associations/organizations mentioned in the Colombian news of the sample 2 was created. The websites of the Colombian associations/organizations were explored to identify, as possible: i) years in existence of the associations/organizations; and ii) profiles of the associations/organizations (i.e., research-oriented, business-oriented; higher education-oriented; or military-

oriented) by reading, when available, about their history, mission, vision, objectives, or current programs.

2. Analysis

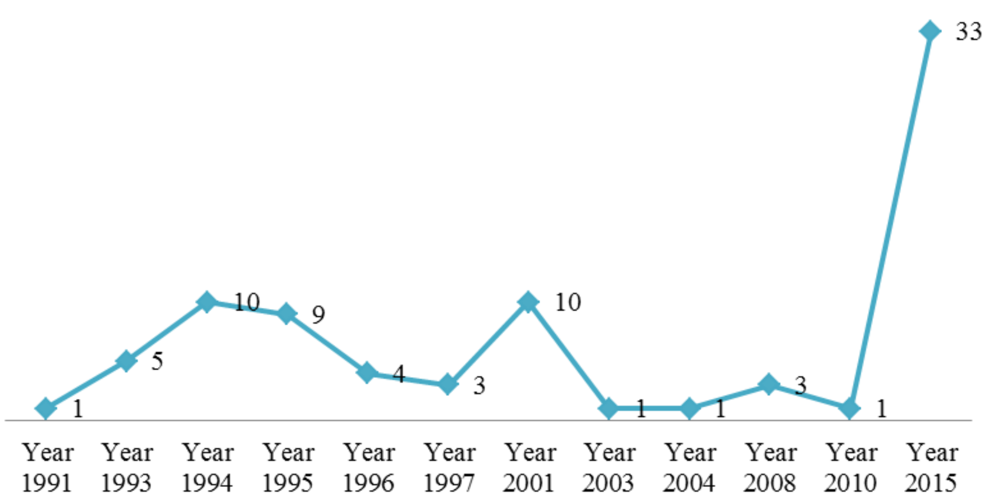
2.1. Presence of digital news on engineering over time in both newspapers

Engineering is a topic that has had presence in the two oldest Colombian newspapers as online news. The oldest online news reported in *El Tiempo* about engineering was in 1990. In *El Espectador*, engineering was present after 2007 as online news.

According to the analysis, *El Tiempo* published 44 news and *El Espectador* 37 news on Colombian engineering. In 1994, 1995, and 2001 in both newspapers, there is a slightly higher presence of digital news on Colombian engineering (e.g., ten articles in each year) when compared to the rest of the years (1991-2010). However, after 2010, particularly in 2015, there is an accentuated growth in contrast to the prior behavior of the data (figure 1).

Figure 1

Distribution of the news on Colombian *engineering* by year in both newspapers *El Tiempo* & *El Espectador*



The digital news on academic events seems to have been a frequent topic between 1993 and 1996. The following is a case of these types of news publicizing an outreach course on “The Use of Computers in Structural Engineering” offered by one of the most important public university in the country, *Universidad Nacional* [19]:

Example 1
News on academic events

Structural Engineering: By: Nullvalue The continued education unity of the Universidad Nacional (National University) will develop an extension course for the Use of Computers in Structural Engineering. It will be held between August 23rd and September 10th, 6-8 in the evening in Bogotá. The lecturers are the engineers Jairo Uribe Escamilla, Fernando Spinel Gómez and Gustavo Cifuentes. El Tiempo 8-23-1993 http://www.eltiempo.com/archivo/documento/MAM-203094

News on college programs and students’ innovations were published between 2001 and 2003, and many more in 2015. The following is a case of this type of news in which a robot designed for defusing explosives is presented as a product of cooperation between academy and military industry undertaken since 2000:

19 In this section some fragments of the news are used to illustrate the analysis. Since the original data is in Spanish, the cases were translated into English. These translations were done by *Ingrid Julieth Hernández Cuero*, senior student of the Degree in Foreign Languages of the *Universidad del Valle* in Colombia.

Example 2
News on college programs and students' innovations

Some universities have made projects for the defense sector

The academy put on its boots


The robot designed for defusing explosives and that was assembled in the la Nueva Granada Military University laboratories was named, for its acronym in Spanish, Vali: light explosion proof vehicle. Its arm which is controlled by a computer that has vision from three cameras connected to the body, gives it precision required for defusing explosive charges. Vali, besides being the name of the Nordic god of archery, is another example of the alliance built between the academy and the military industry since 2000.

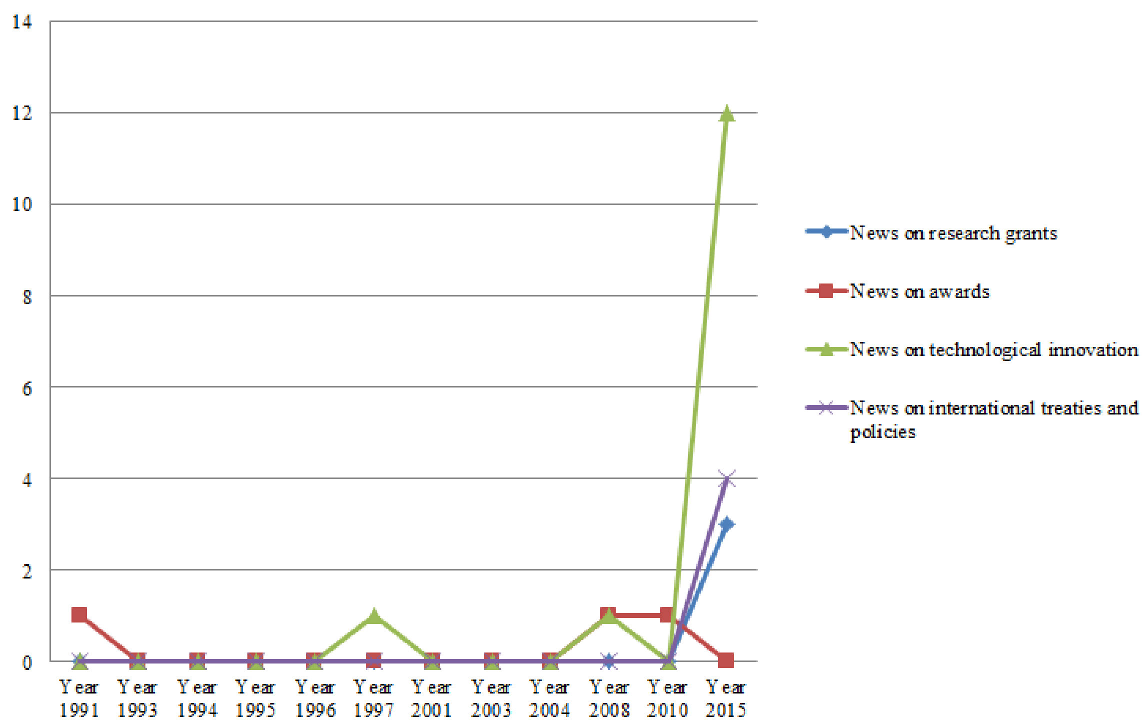
El Espectador
3-24-2015
http://www.elespectador.com/noticias/nacional/academia-botas-puestas-articulo-551287

The news on international treaties and policies, research grants, awards (non-presence until about 2008 and 2010), and technological innovation were rare (slightly present in 1997 and 2008) (figure 2). The next is an example of news on technological innovation published in 1997 in which research on transgenic plants was publicized as part of the agendas of The Colombian Corporation of Agricultural Research (*Corpoica*):

Example 3
News on technological innovation

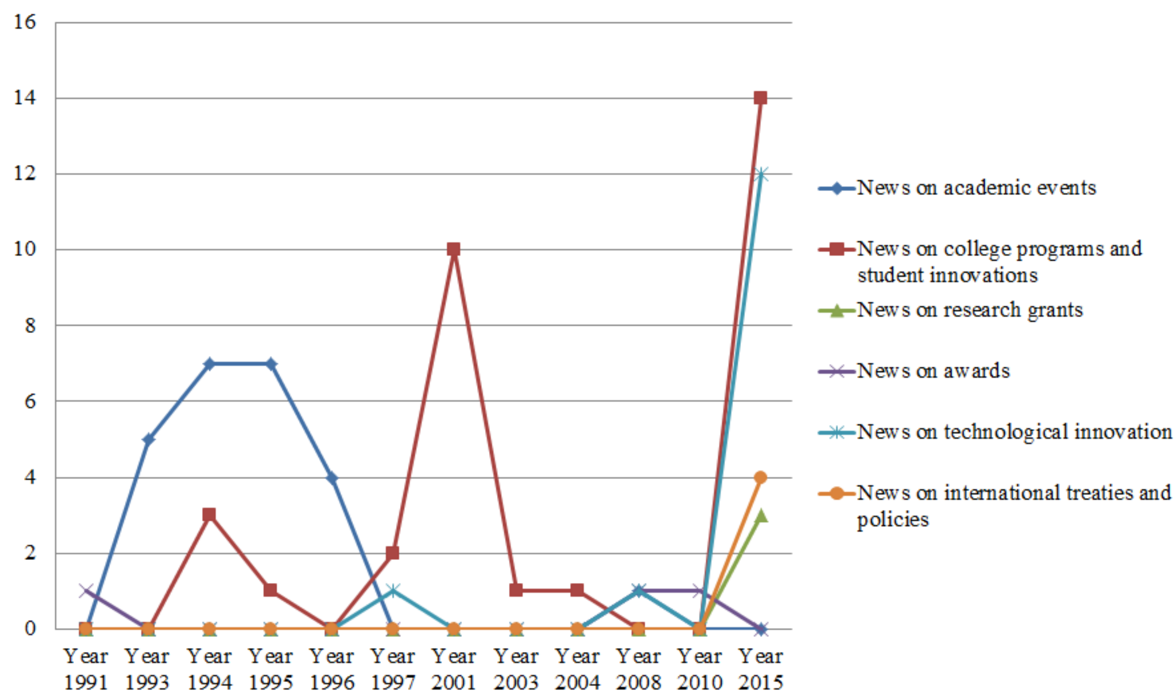
> **Now it's time to produce square fruits!**
>
> Nearly about two decades ago, the multinational Mc Donald's did not know what to do with the tomatoes' leftovers after making hamburgers, since from a big fruit they could only use three or four slices from the center of it, while the rest had to be thrown away because it was not the hamburgers' size.
>
> Colombia. The Colombian Agricultural Investigation Corporation (Corpoica in Spanish) is the only institution that has obtained some progress in developing transgenic plants. However, there is still a lot of time left for commercialization of results. Other research centers, especially from universities, have been working on this for a long time to improve knowledge about laboratory genetic handling.
>
> El Tiempo
> 07-22-1997
> http://www.eltiempo.com/archivo/documento/MAM-598532

Figure 2
Distribution of the occurrences of the news on engineering related to research grants, awards, technological innovation, and international treaties and policies



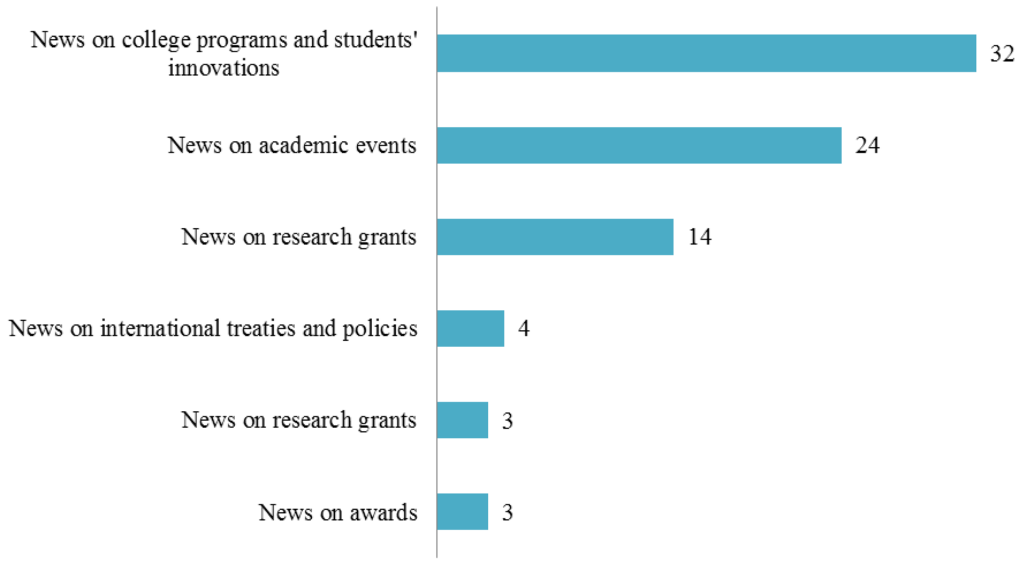
However, news on technological innovation grew dramatically after 2010, particularly in 2015, when comparing data behavior of prior years (see the light blue line behavior depicting news on technological innovation across the years in figure 3).

Figure 3
Distribution of the occurrences of the types of news on engineering displayed over time in both newspapers *El Tiempo* & *El Espectador*



The most two frequent types of news were on college programs and students' innovations (32cases) academic events (24 cases) (figure 4).

Figure 4
Distribution of the occurrences of the types of news on engineering in both newspapers *El Tiempo* & *El Espectador*



2.2. Presence of engineering fields

The news of the sample mentioned a broad spectrum of engineering subfields (e.g., Civil engineering, Electronic engineering, and Naval engineering). However, the news has been published to primarily publicize issues on engineering in general as one field (20 cases out of 98 mentions), and about computer engineering as a subfield (17 cases out of 98 mentions) (table 1). This emphasis in computing engineering might have a relationship with the amount of mentions related to computers. There were 34 mentions for computers, 17 mentions for robots or machines, and 7 mentions for labs.

Table 1
Distribution of the fields mentioned in the news

Field	Occurrences
Engineering	20
Computer engineering	17
Civil engineering	9
Electronic engineering	5
Naval engineering	5
Chemical engineering	4
Telecommunications	4
Industrial engineering	4
Military engineering	4
Mechanical engineering	3
Aeronautical engineering	2
Agricultural engineering	2
Electrical engineering	2
Structural engineering	2
Artificial intelligence and nanotechnology	1
Civil and construction engineering	1
Economic engineering	1
Electric engineering	1
Architecture	1
Seismic engineering	1
Engineering on plastics	1
Environmental engineering	1
Hydrology engineering	1
Hydrologic engineering	1
Administrative engineering	1
Production engineering	1
Cardiovascular-biomedical engineering	1
Mining engineering	1
Biomedical engineering	1
Total of mentions	**98**

2.3. News with implications for Higher Education with special focus on learning writing, language, and communication

The articles of the sample address the three educational levels: professional (44%), graduate (35%), and undergraduate (21%). 49% of the news items of the sample (40 out of 81) mentioned implications in higher education, either for research or curriculum in engineering. The following is an example of news with implications for higher education curriculum in which the major in Marine Engineering was established as profession since 1995:

Example 4
News with implications for higher education curriculum

> **Marine Engineering:**
> It is already a profession. This is what the Senate VI Commission established after approving the law project presented by the senator Jairo Clopatofsky.
> El Tiempo
> 10-28-1995
> http://www.eltiempo.com/archivo/documento/MAM-439540

The next is another example of news publicizing implications for research, which presents in 2015 an innovative technique for regenerative vascular grafts made out of pig intestine and developed by a Colombian researcher who is specialized in Biomedical Cardiovascular Engineering:

Example 5
News publicizing implications for research

> **Saviour Grafts**
>
> 
> One of the problems dialysis patients have to face is that through time their veins get damaged and there are no more places for making the punctures. An innovative technique of regenerative vascular grafts from the pig intestine could be a solution.

> Even if medicine runs through the veins of Juan Cralos Briceño because his father was a doctor and his mother a nurse, he did not want to follow the same path. He decided on Mechanical Engineering and when he did his undergraduate thesis he found the relationship between these two professions.
>
> He created intramedullary nails to use in tibia fractures, immobilizing the fracture without the need of a plaster and avoiding infections. Later, he worked as a research assistant in the Andes University and while he worked for the Cardio Infantile Foundation in Bogotá, he realized that the combination of the two professions was possible through a master's degree in Biomedical Cardiovascular Engineering. He traveled to Texas to study it and 20 years ago he got back to Colombia to work on various engineering projects that may be helpful for the health.
>
> El Espectador
> 3-23-2015
> http://www.elespectador.com/especiales/injertos-salvan-articulo-551054

The analysis of types of implications for Higher Education (HE) suggests that educational issues have been mentioned in the online news since 1994 (blue boxes in figure 4) and implications associated with learning on writing, language, and communication are concentrated in 2001, then reappeared in 2008 and 2015 (green boxes in figure 5).

Figure 5
Distribution of the mentions on implications for higher education (blue), and learning on language and communication (green) over time

There is a continuous presence between 1997 and 2001 of news concerning new college programs in engineering. The following is an illustration of this type of news offering new undergraduate programs, including computer engineering that was launched in 1997 by a private Colombian institution, which might be regarded at the level of city college systems in the U.S. higher education context:

Example 6
News concern new college programs in engineering

> **Discerning professionals**
>
> REF. The sole requisites are the will and desire of growth. No more excuses for quitting studying. The Cooperative University of Colombia offers you careers in Law, Administration, Accountancy and Systems Engineering.
> The first steps. The Constitution of 1991 and the Law 30 of 1992 under which the Higher Education is reformed in the country, open an important space for solidary economics institutions as alternatives for social transformation, property democratization and service delivery.
>
> El Tiempo
> 4-30-1997
> http://www.eltiempo.com/archivo/documento/MAM-641820

Furthermore, stories about university research projects for innovation (research institutes, graduates, or undergraduates working in research projects) and advocating for research-oriented reforms appeared mainly in 2015. The next case is an article in which a candidate running for chancellor of one of the most important public universities in Colombia, *Universidad Nacional*, urges planning national reforms for education systems, and agendas of science, technology, and innovation:

Example 7
Stories advocating for research-oriented reforms

> A candidate for the rectory in the National University speaks
>
> **The Society Challenges of Knowledge in Colombia**
>
> Óscar Almario, PhD in Social and Cultural Anthropology of the Sevilla University in Spain and candidate to the rectory of the National University wrote a column for El Espectador about the diverse changes that globalization has brought to the country.
> In the actual globalized world the known “Knowledge society” is perceived as the intensive use of education systems and science, technology and innovation (CT&I) to transform realities socially, economically, politically and culturally adverse in favor to

the integral development, the environment preservation, the sustainable profit of resources, the mobility and the social inclusion, and the social and political stability goal of the countries.
In this context, Colombia appears to be a unique country. Indeed, its five geographic macro-regions, the ethnic, social and cultural diversity make it the most bio-diverse country of the planet. However, it is one of the most unfair and socially excluding countries in Latin America.
Colombia has been obliged to go through a complex inside conflict for half a century. Regardless of the efforts for modernizing and broadening the coverage of our education system (Basic, High School and College), this agenda is delayed compared to others from other regions. The same situation occurs with the national system of CT&I.

El Espectador
3-22-2015
http://www.elespectador.com/noticias/educacion/los-retos-de-sociedad-del-conocimiento-colombia-articulo-550902

However, the expectations on educating engineers within curricula that are research-oriented to impact scientific progress nationwide appear in the sample since 2001. The following case, published in 2001, is publicizing a major in Telecommunications Engineering and mentions that applicants must be eager to conduct research:

Example 8
Expectations on educating engineers within research-oriented curricula

Telecommunications Engineering
Systems Integration Experts

A Colombian industrial closes the business of his life with the most important exportations enterprise of Japan. Without moving from his office this businessman convinces the Japanese of his product benefits and creates a new commercial relationship that will represent millions of dollars a year for the country.

Study Program
The career lasts nine semesters and has an important theoretical foundation combined with the practice in electronics and systems. This practice is made in laboratories designed especially for these purposes.

The curriculum is composed by courses related to mathematics and physics, electronics and systems, telematics, communications and transmissions. Given its research character, the students must take the courses of the administration area and the projects management.

What are the abilities expecting from you?
The candidate for Telecommunications Engineering must have a profile guided towards mathematics and physics. In the same way, he must be creative and enthusiastic for research.

El Tiempo
3-28-2001
http://www.eltiempo.com/archivo/documento/MAM-577223

Only in 2015, the following four topics emerged as implications for Higher Education (HE):

1) The importance of curriculum reforms to favor progress on science and innovation. For example, the following case reports the visit of an international consultant, a Spanish biologist female researcher and entrepreneur, advising the Colombian Government in 2015:

Example 9
The importance of curriculum reforms to favor progress on science and innovation

> **"Innovation is attitude"**
>
> 
>
> The woman who got to put the Spain politic parties into an agreement point to reform science and innovation in her country is now Santo's government counselor.
>
> Cristina Garmendia is a biology doctor. In 1997 she founded Inbiomed, a center that harbored the first mature stem cells bank in Spain. From 2008 to 2011 she was the minister of Science and Innovation of that country. During that time she assured that 346 of the 350 parliamentarians put aside their politic differences and voted for a Science, Technology and Innovation Law.
>
> Now, she is the assessor of investigation and development in the Productive Transformation Program belonging to the President Juan Manuel Santos' government. The Rosario University awarded her the last week. During the conference she gave in the Maximum Hall, she talked about four tendencies that rule innovation in the world today.
>
> El Espectador
> 2-13-2015
> http://www.elespectador.com/noticias/actualidad/innovacion-todo-actitud-articulo-544018

2) The emergence of a program to favor access in HE for non-traditional students (e.g., students from disadvantaged sectors of the population). The next case illustrates an emerging national initiative led by the Ministry of Education that is funding outstanding students from disadvantaged sectors who pursue undergraduate programs in accredited private and public universities:

Example 10
The emergence of a program to favor access in HE for non-traditional students

The scholarship holders share their experience

Ser Pilo Paga, a great experiment


The leading program of the Mineducación (Ministry of Education) took the shape of "I Want to Learn", the initiative the Andes University took and that has given scholarships to students with economic disadvantages. The beneficiaries' experiences could be the clear evidence of what the 10.080 beneficiaries are awaiting for.

"I got there in 2012. I felt excited because being a grant holder is a big life accomplishment to be proud of, although, deep in my heart I was scared about knowing with students who talked two or more languages, who have money and a lifestyle different than mine. But more than that, I felt the common feel a scholar has, it does not matter if you are undergraduate from a Colombian university or in doctorate degree in the best university of the world, you fear failure", said Harry Ramos, student of the seven semester of economy.

El Espectador
01-24-2015
http://www.elespectador.com/noticias/educacion/ser-pilo-paga-un-gran-experimento-articulo-539804

3) The crisis in educating and recruiting engineering students. The following case mentions, according to the female leader of a trade association on software and IT technologies, the lack of Colombian professionals in engineering, even though innovation enterprises have recently increased:

Example 11
The crisis in educating and recruiting engineering students since school years

The Fedesoft leader Paola Restrepo says

"People do not want to study Engineering"


Even if in the country there are 1.600 innovation enterprises and 950 of them are devoted to software development, an industry crisis is foreseen given the lack of human talent.

The country that has its eyes on the information technologies is facing a very dark storm cloud about the business. This problem is not a consequence of the poor sales, or the lack of resources or creativity. This is due to the lack of talent. In a market that has $5, 9 billions of income, there is an absence of people who would like to study one of the professions most desired by the leading enterprises of the world nowadays. Paola Restrepo, president of the Colombian Federation in the Industry of Software and Related Technologies (Fedesoft) explains the situation.

El Espectador
02-11-2015
http://www.elespectador.com/noticias/economia/gente-no-quiere-estudiar-ingenieria-articulo-543544

4) Studying overseas (either getting graduate education or internships in multinationals) as a professional option in the field. The following fragment illustrates a case reporting about a study on professional expectations of Colombian architects and engineers, in which graduate education and overseas exchanges are seen as important options for career promotion:

Example 12
Studying overseas (either getting graduate education or internships in multinationals) as a professional option in the field

The Colombian Architects and Engineers Optimism

A study assures that 61% of the professionals of these areas in the country believe their jobs will be secured in 2015.

The "Barometer 2014-2015" of Structuralia about engineering and architecture professionals perspectives was made in Spain, México, Perú, Chile and the rest of

Latin America including Colombia. In the latest, this Barometer showed that 61% of the people who work in these two fields consider their job is guaranteed until 2015, besides 38% of them think they will be promoted.

Juan Antonio Cuartero, the director of Structuralia.com warned that "the majority of these professionals not only consider that their job is under no risk, but also that there are possibilities of professional promotion. In Colombia a 38% of people believe they will get a job promotion". The survey was applied to 2.000 people and it determined that from 40% to 50% of architects and engineers will be willing to go out of the country with the condition of a 50% rise in their payment.

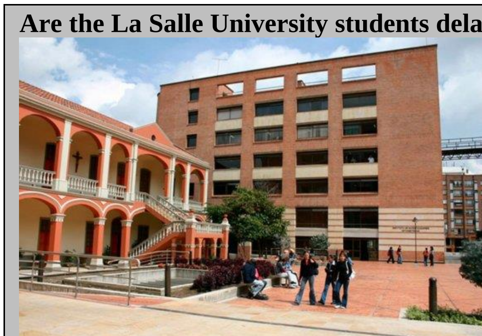
In other numbers it was found that 70, 21% of the professionals speak English, 22, 28% of them speak French and 5, 96% speak German. A 52, 17% of them all have complementary postgraduate degrees. "Even if there is a big local need for professionals, a big part of them do not close the door after going out for a season or for a foreign project. Every time, postgraduate studies and a season out of the country are seen as an additional step for the professional promotion", explained Cuartero.

El Espectador
2-20-2015
http://www.elespectador.com/noticias/economia/el-optimismo-de-los-arquitectos-e-ingenieros-colombiano-articulo-545335

Regarding writing, language, and communication, the analysis suggests that writing a senior thesis (purple boxes in figure 5) and English learning (dark pink boxes in figure 5) have been types of learning expectations in college programs since 2001. In 2001 and 2015, there are mentions on English learning (dark pink boxes in figure 5) as an expectation in the field. The next 2015 news reports about a crisis in fulfilling the English requirement for degree completion of about 1,500 undergraduate students in Optometry, Public Accounting, and Engineering in a religious private university located in the capital of the country:

Example 13
English learning expectations in college programs

Are the La Salle University students delayed in the English learning?



There is a big group of students whose graduation has been stopped due to the lack of English courses. Nevertheless, the University says it was them who postponed it until the last moment.

Nearly 1.500 students from different faculties of La Salle University are anguished on these days. The reason is that they want to graduate, but they still lack the foreign language requirement that allows them to go to prom or at least get their diploma outside the ceremony.

The students are from Optometry, Public Accountancy and Engineering of the night group. They made use of the social networks and made daily direct contact in order to show their inconformity for the way in which La Salle manages this conditions to obtain the professional diploma.

El Espectador
2-18-2015
http://www.elespectador.com/noticias/educacion/les-cogio-noche-el-ingles-los-estudiantes-de-salle-articulo-544799

As for a senior thesis requirement (purple boxes in figure 6), these are mentioned in 1997, 2001, and 2008. The next case is an example of news in 2001 that is publicizing a major in Plastics Engineering comprised of two degree cycles. Thus, the senior thesis requirement is mentioned to pursue a professional degree; otherwise the student only earns a technician degree:

Example 14
The senior thesis requirement

Plastics Engineering

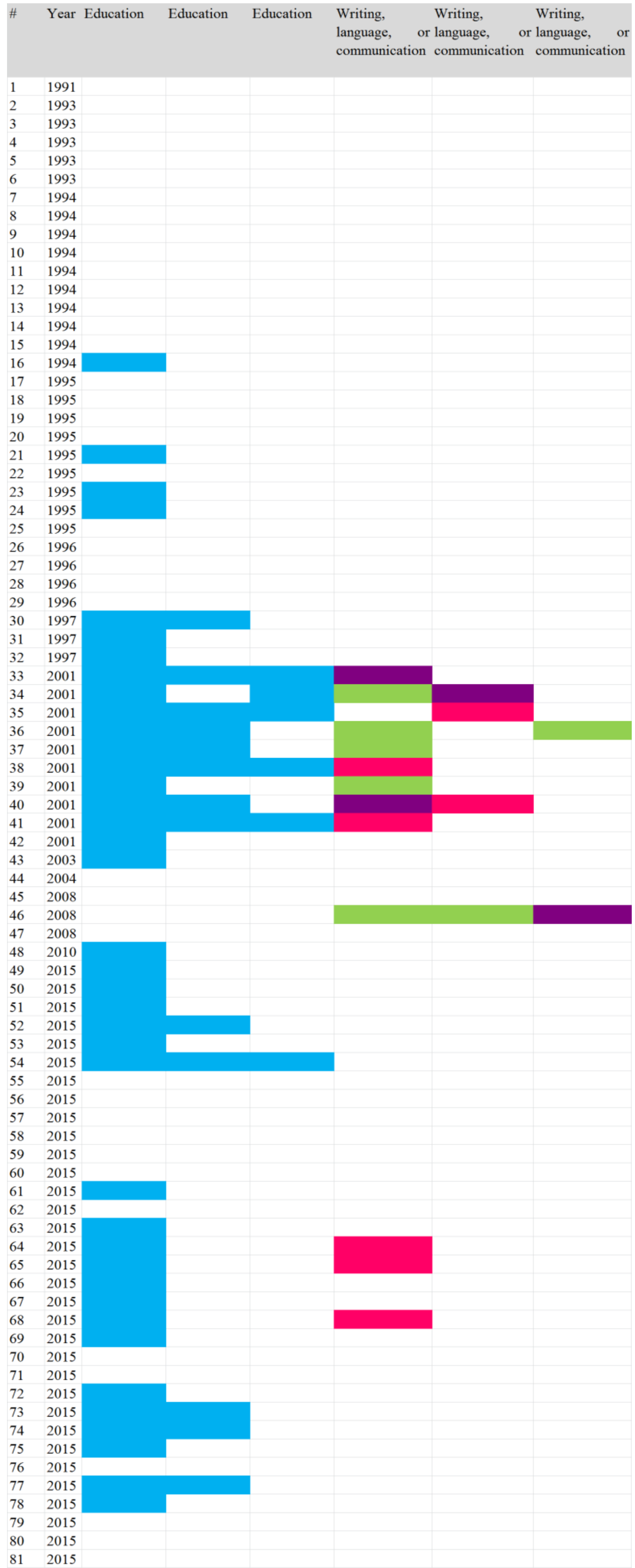
This is how a professional is made.

The Plastics Engineering career is done in two cycles. First, if the student wants to opt for the professional technician title, he must study five semesters plus one for the development of his thesis (P#1).

The second cycle of professionalization lasts just the same as the former. After a thesis, the Plastics Engineer title is obtained (P#2).

El Tiempo
10-31-2001
http://www.eltiempo.com/archivo/documento/MAM-686347

Figure 6
Distribution of mentions on implications for higher education (blue), learning on language and communication (green), English learning (dark pink), and writing a senior thesis (purple)



Incorporating the study of language (oral, written, and graphic abilities) and communication theories (verbal and visual) also emerged as expectations of educating engineers. The following case is an example of an article published in 2001 in which a major in Industrial engineering is publicized while written and oral graphic expressions are also mentioned as course requirements:

Example 15
Incorporating the study of language and communication theories for educating engineers

> **Industrial Engineering, much more than just businessmen**
>
> The integral training o the industrial engineer provides him tools to face administrative, commercial and financial problematic of the enterprises.
>
> Independently of his approach, the career curriculum includes courses of Mathematics, Economy, Administration, Marketing, Industrial Relations, Systems, Statistics, Physics, Chemistry, Foreign Trade, Electronics, Thermodynamic, Robotics, written and oral Graphic Expression, Job and Commercial Right, etc.
>
> El Tiempo
> 3-28-2001
> http://www.eltiempo.com/archivo/documento/MAM-577258

However, in some cases, language and writing are regarded as a "basic" ability or general education course, whereas in other cases they are mentioned as tied to disciplinary education in the field. The next news illustrates a case in which language and writing are seen as a "basic ability". This news published in 2001 offers a general education program for engineering students who might be unsure about the engineering subfield they will pursue when applying to university admissions[20]:

Example 16
Language and writing as "basic abilities"

> **General Studies and General Engineering: options while you choose**
>
> Choosing a career is the most important decision a student makes just after High School. In many cases, this decision is hard and not always definitive. Students often change their mind about their careers, because they do not feel satisfied with them. This problem occurs both in debutant students and in the advanced ones.

20 In the Colombian case, students declare their majors when applying to universities.

> The basic and instrumental courses give the student the tools to perform in any knowledge area, such as Mathematics, Language management and Investigation techniques.
>
> El Tiempo
> 3-28-2001
> http://www.eltiempo.com/archivo/documento/MAM-578362

The following case is an illustration of mentions on language and writing tied to disciplinary education. In this case, the news is offering a major in Electronic and Telecommunication Engineering in which Communication theories are mentioned as part of the Humanistic component of the curriculum:

Example 17
Language and writing tied to disciplinary education

> **Electronic and Telecommunication Engineering: Helpful Technology Creators**
>
> The Colombian productive sector requires each time younger specialized professionals who may contribute into the industrial processes of our country.
>
> The Humanities area is comprised of courses of Philosophy, Communication theories, and capstone projects.
>
> El Tiempo
> 3-28-2001
> http://www.eltiempo.com/archivo/documento/MAM-577276

2.4. Associations/organizations mentioned in the news

Out of 81 cases of Colombian news on engineering, 54% mention at least one organization/association. The total of organizations/associations mentioned were 60, from which 40 are Colombian organizations/associations or Colombian branches of international ones.

According to the information, when displayed by the websites of these organizations/associations, at least three institutions have a century in existence (highlighted in yellow in appendix 2), ten have at least 50 years (highlighted in light blue in table 2), and the other five have less than a decade (highlighted in light pink in appendix 2).

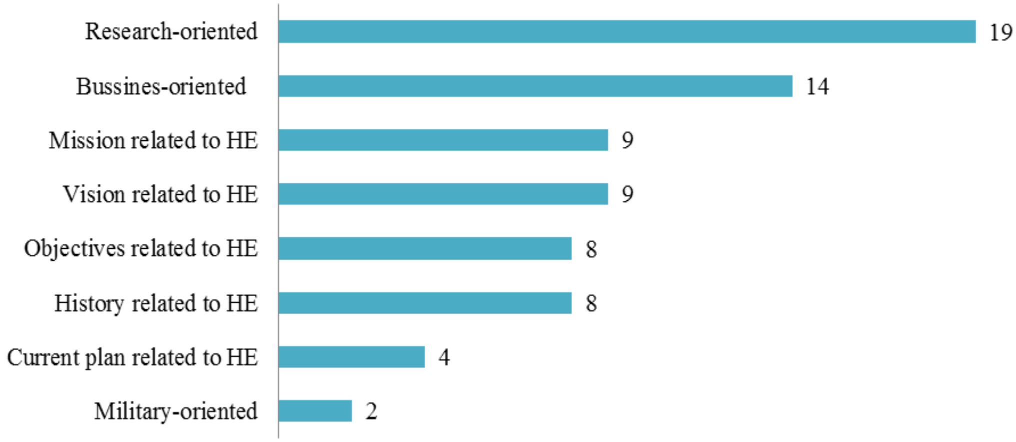
The institutions are primarily business-oriented (14 cases) and research-oriented (19 cases) rather than military-oriented (only 2 cases) (figure 6). Organizations that are education-oriented are approximately 9 cases (the list of the organizations that are business-oriented and research-oriented organized by foundation date from oldest to youngest is in appendix 3). Table 2 provides examples of profiles of the associations/organizations.

Table 2
Examples of profiles of the associations/organizations

Category	Example of organization	Products or services[21]	Link
Research-oriented	Instituto Colombiano Agropecuario	We work for agriculture and livestock and for food safety to project Colombian agribusiness to the word On 1962, Colombian agriculture and livestock Institute Corporation was created by Decree 1562 from June 15th, to coordinate and intensify agricultural sciences research, teaching and extension work for a better and more harmonious development of all sector activities and specially to facilitate social agricultural reform.	http://www.ica.gov.co/El-ICA/Mision.aspx http://www.ica.gov.co/El-ICA/Historia.aspx
Business-oriented	Banco Colombiano de Comercio Exterior (Bancoldex)	The entrepreneurial Colombian bank offering support to boost productivity, growth, and competitiveness of small and big companies to trade nationally and internationally.	http://www.bancoldex.com/acerca-de-nosotros92/Historia.aspx
Higher education-oriented	Asociación Colombiana de Facultades de Ingeniería	Issues related to Faculties of Engineering (curriculum, assessment, policies, research)	http://www.acofi.edu.co/
Military-oriented	La Corporación de Ciencia y Tecnología para el Desarrollo de la Industria Naval, Marítima y Fluvial (Cotecmar)	Products and services for Naval Army and naval industry	http://www.cotecmar.com/

21 These fragments in some cases were taken from the actual websites and in other cases were paraphrased by the analyst to describe the products or services of the organizations/institutions.

Figure 7
Occurrences of the profiles of the Colombian associations/organizations



D. Contextualizing the field of Technical Communication: The U.S. Scholarship

Since in Latin America there is no specific field equivalent to Technical Communication as developed in the U.S. This section of the chapter offers a literature review to contextualize the U.S. scholarship that will be useful to later discuss the literature review on technological innovation and economic growth in Latin America and public expectations displayed chronologically by the news on Colombian engineering. This comprehensive overview describes the field in three groups: a) Practitioners' roles and professional expectations; b) Influence of digital technologies in visual design, documentation, and interactions; and, c) Science communication and public communication of science.

Practitioners' roles and professional expectations

The roles of practitioners in the field of technical communication are highly affected by the rationality of the economy in the globalization age (Faber & Johndan Johnson-Eilola, 2002). Practitioners, for instance, are expected to: a) translate and edit in English documents of products and services that are offered outside of the U.S. markets (Giamonna, 2010) such as printed and digital manuals for manufacturing goods and explaining scientific and engineering innovations to non-specialized readers; b) make disciplinary and specialized contents accessible (i.e., legal contents) to non-specialized audiences; c) become experts in global communication to interact with diverse cultures; and, d) design online materials and communicative products that are appealing for international audiences.

For some scholars, technical communicators are symbolic analytic workers who interpret users' needs and whose professional practices are associated with business agendas (Selfe & Selfe, 2012). For instance, outsourcing practices make visible that products not only compete based on design, function, usability, and value, they add to consumers, but also innovation of new products and methods of production (Faber & Johndan Johnson-Eilola, 2002). Thus, practitioners are expected to become collaborative product developers and to lead initiatives as project managers (Giamonna, 2010). The professional space of practitioners is not too well defined due to technical communication problems requiring more than one solution; consequently, some have pointed out that practitioners are expected to know how to work collaboratively while interacting with many audiences and technologies (sociotechnical mediation) (Mehlenbacher, 2012).

Digital technologies, visual design, and documentation

The impact of digital technologies in visualization also shapes professional expectations of specialists in the field of Technical Communication. As a result, practitioners must also develop knowledge to organize and design visual contents. Studies in workplace settings reveal that visual resources are leveraged by technical communicators from prior visual designs; thus, one of the skills expected from professionals is to revise and locate prior designs. New visuals are only developed when new products are launched. In visual design, creation and innovation depend on software knowledge held by the technical communicator, experience with the subject matter, and time to produce the design. It has been stated that the relationship between engineers and technical communicators is complex in workplace settings, since engineers think technical communicators have no knowledge of design process (Craft, 2010).

Since interactions between visual and non-visual elements in design are professional expectations in Technical Communication, visual rhetoric is required professional knowledge. Visual rhetoric (decision making process about including visual elements in technical documents and digital deliverables) is a fundamental component in complying with international standards of safety consumption of products and services (Craft, 2010).

Technical communicators are also expected to learn about storage and retrieving documentation. Practitioners must develop documentation skills to interact in computational environments in industrial and networked economies (MacDaniel & Steward, 2011). Therefore, technical communicators are also regarded as informational architects (Giamonna, 2010).

Digital technologies affect language use, communication, and interactions. Studies on information design and computer documentation argue that designers should include unofficial ways to solve problems to incorporate recursive procedures developed by users; within this approach, technology is interpreted and reinterpreted by users during interactions. Consequently, unpredictable and unofficial ways in which workers exert their own agency to solve individually or cooperatively recurrent problems are key sources of information for computer documentation (Spinuzzi, 2003).

Science communication and public communication of science

Practitioners of the Technical Communication field might be involved with the field on science communication, particularly on the public communication of science. In public communication of science, risk communication can refer to both research and practice. As research, risk communication covers a broad range of topics: psychology-based research on risk perception; cognitive processing of risk information and social amplification of risk; critical-cultural and sociological theories of risk discourse in society; and, rhetorical criticism and theories of risk communication. Scholars of risk communication belong to different disciplines (i.e., psychology, sociology, rhetoric and professional communication, anthropology, and policy studies) and are researchers-practitioners from outside of academia (i.e., governmental agencies, public health, or independent consultants of government and industry). Some scholars of science communication criticize deficit models of Public Understanding of Science and instead embrace a contextual and dialogic model. This model deconstructs hierarchical separation of reason and emotion; thus, risk holds a rationality, which legitimates public's emotional responses to avoid seeing the risk as "irrational" (Spoel & Barriault, 2011).

The field of Technical Communication also includes studies on discursive realities of technical reports/genres that reconstruct disasters of the mining industry. The study conducted by Beverly A. Sauer, titled "*The rhetoric of risk: Technical documentation in hazardous environments",* unfolds complex discursive practices, such as: a) legal acts and public policies that mandate miners' training; b) understanding complex laws in regulating mining activity and preventing disasters from perspectives of stakeholders (foremen, inspectors, supervisors, and managers); and, c) writing of standards and regulations (Sauer, 2003).

This study shows that defining standards for high levels of safety implies embracing diverse sources of information, such as: scientific information, diverse political and economic agendas of stakeholders, rationality of standardization, and contents of massive technical reports of catastrophes. Standards that are defined after fatalities must regulate safe mining exploitations including procedures of risk emergency for stakeholders, which is challenging, since standards are heterogeneous texts that present expert knowledge in lay language. Moreover, “expert knowledge” includes local and common sense of foremen and managers as a result of accumulation of individual narratives. Additionally, standards offer solutions that over time become outdated; thus, revision and updating are also difficult (Sauer, 2003).

Ultimately, Sauer’s work shows that the revision process of standards reveals hundreds of revisions and re-revisions done by agencies (at least 40 times), which makes it problematic to differentiate – at some point of the process – roles of writer, respondent, reviser, and audience. Reviewers make visible the flaws in the presentation of evidence from opponents’ point of view; however, the opponent vantage point is difficult to demarcate because these documents are addressing diverse and even conflicting audiences (Sauer, 2003).

Technical documentation for technology transfer is also a technical communication practice related to the field on science communication. Intellectual property is a class of asset in capitalism that requires governmental control mechanisms. To create profit of an idea, the idea must be owned by someone; thus, ideas become knowledge by entering in a system recording “owned ideas” (Bazerman, 2002). Technology transfer is the process of communicating a complex idea in plain language to be sold or licensed for business. Patent titles and patent applications are written in specific genres of legal language of patents. A patent application is filed with the U.S. Patent & Trademark Office (USPTO) and negotiated from multiple points of view, including of the inventor, patent attorney, and patent examiner.

Technology transfer professionals participate in connecting research and industry, translating patent language to plain language to specific and local communities, and defining details of licensing agreements; thus, moving from technical descriptions to plain language is the core of technology transfer. These practices involve technical communicators to understand patent contracts and rules of disclosure. Technology transfer practice is narrowly regarded as lawful problems rather than a rhetorical phenomenon. Therefore, for some scholars, technical writers and communicators must become knowledgeable about legal framework of patent prosecution, technology transfer, and patent disputes to participate actively by incorporating rhetorical perspectives in solving technology transfer problems (Smith Diaz, 2014).

This literature review confirms that practitioners of technical communication work in corporations and public service organizations (Selfe & Selfe, 2012), and are also involved in scientific and technical writing (Miller, 2004). Practitioners are expected to write with clarity by using plain or lay language, and incorporating conventions of emerging genres from the influence of digital technology; as a result, flexibility and rhetorical skills are necessary. Writing processes of practitioners highly vary according to factors such as: mastery of technological skills to produce documents, interpersonal skills to negotiation, and flexibility for unexpected changes (Blakeslee & Savage, 2012).

This overview confirms that Technical Communication is an interdisciplinary field developed in the U.S. as an historical and evolutionary interaction among economic changes, scientific developments, and digital technology innovations. This might explain the strong relationship between the agendas in the field and the changes that have been ensued in non-academic contexts as companies and research corporations. This literature review also displays a complex dualism in educating practitioners to fulfill expectations of profit-oriented organizations and gain critical awareness of rhetorical conditions by which science, technology, and other corporate knowledge are created.

E. Research agendas for technical communication in Colombia

This section triangulates the literature review of the U.S. scholarship of the field in Technical Communication, the literature review on technological innovation and economic growth in Latin America, and the chronological analysis of the online news on Colombian engineering to propose research agendas on Technical Communication for Colombia.

Practitioners of Technical Communication in the U.S. are expected, among other issues, to translate and edit in English documents of products and services offered outside of the U.S. markets (Giamonna, 2010); abilities for writing in English are also a learning expectation emerging from the Colombian news with Higher Education implications on college (cases # 35, 38, 40, 41, 64, and 68 in appendix 1). Furthermore, in the news of 2015, graduate education and internships in multinationals seem to be a significant professional option in the field (cases # 3, 34, 35, 64, and 77 in appendix 1). Therefore, an interesting research site in the Colombian case might be to analyze the English curriculum for engineering majors, and also language programs other than English that are offered to engineering majors (e.g., Mandarin Chinese, Portuguese, Korean, and German) to explore types of learning expectations and interactions, if any, with professional goals.

The literature review on technological innovation and economic growth in Latin America suggests that Latin-American firms act as “price takers” (Katz, 2000), which means that have little bargaining power and obtain low profits (Katz, 2000). This might suggest that Latin-American professionals related to the different sectors favored by the reforms since 1980 (i.e., non-tradable sectors such as telecommunication, energy, financial services, natural resource-processing industries, electronic/garment, and automobile assembly plants) (Katz, 2000) might be exposed and "enculturated" under communicative practices of "price takers", which may imply language practices undermining opportunities for negotiation and argumentation. This hypothesis might be further tested by conducting studies on communicative practices of negotiations between Colombian and foreign entrepreneurs to later inform curriculum initiatives.

Furthermore, since one of the non-tradable sectors favored by the economic reforms has been the natural resource-processing industries (iron, steel, petrochemicals, nonferrous minerals, fishmeal, vegetable oil, pulp and paper) (Katz, 2000), conducting studies on public communication of science and risk communication (Sauer, 2003; Spoel & Barriault, 2011) might be also be an interesting research site in the region.

The interrelated nature of visual and verbal design in the field of Technical Communication (Craft, 2010) is also present as learning expectations in the Colombia case through digital news in 2001 that publicized engineering majors by newspapers (cases # 34, and 39 in appendix 1). Therefore, how these curriculum goals have been undertaken in Colombian engineering majors might be another important research site to explore contributions that writing advocates might offer under the frameworks of the field of Technical Communication.

Furthermore, although the economic Latin-American progress in the 80's seems to negatively affect technological development in telecommunications or informatics (Vonortas, 2002), the analysis of the Colombian news unfolds a public interest on computer engineering (17, 35% of the news mentioned this field) particularly in 2015. Consequently, practices on information design and computer documentation (Spinuzzi, 2003; Giamonna, 2010;

MacDaniel & Steward, 2011; Lamberti, 2011) might be research topics to address in the Colombian case.

Regarding technical documentation for technology transfer (Smith Diaz, 2014), there have emerged, in the Colombian case, research niches to explore how this phenomenon has been undertaken. The literature review on technological innovation and economic growth in Latin America confirms that systematic policy thinking on S&T policies dates since early 70's and research funding remains low and is allocated primarily in public agencies and universities (Vonortas, 2002); however, the analysis of Colombian news in 2015 also uncovers online news that publicize on universities that are participating in research projects for innovations (research institutes, graduates, or undergraduates working in research projects) (cases # 30, 32, 33, 35, 36, 40, 41, 50, 51, 63, 67, 69, 75 in appendix 1). The literature review also suggests that intellectual property protection laws have been strengthened since the 80's (Vonortas, 2002), and in the Colombian case, since 1997, research or students' innovations in engineering are types of digital news published by the newspapers (Example case # 30 in appendix 1). Additionally, the sample reveals that since 2001 the news on new engineering majors are advocating for a research-oriented curriculum that in some cases is linked to writing a senior thesis as a requirement for program completion (cases # 33, 34, 40, 46 in appendix 1). Accordingly, nowadays in the Colombian case, it might be necessary to conduct studies on documentation for technological transfer that might be a phenomenon mainly circumscribed within universities through undergraduate and graduate education in engineering.

The analysis of the organizations/associations mentioned in the Colombian news reveals that engineering has grown primarily as a business and research-oriented field rather than as a military one (only 4 cases against 20 cases of organizations business-oriented, and 17 research-oriented), and might date in the country since more than a century (e.g., *Escuela Colombiana de Ingenieros, La sociedad colombiana de ingenieros, and La industria militar de Colombia*). Studies on exploring historical and current technical and scientific communication practices embedded in the organizations that are business-oriented and research-oriented (e.g., *Banco Colombiano de Comercio Exterior -Bancoldex-, ANDI - Asociación Nacional de Empresarios de Colombia, Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia – IDEAM, and Invima -Instituto Nacional de Vigilancia de Medicamentos y Alimentos*-) might inform on learning expectations for national and international technical communication programs.

In the cases of Colombian organizations/associations related to higher education issues (e.g., *Asociación Colombiana de Facultades de Ingeniería, Facultad de Ingeniería de la Universidad de Antioquía, Observatorio Laboral del Ministerio de Educación*), it might be important to explore further their current agendas, especially because the analysis on Colombian news in 2015 reveals topics related to educational implications: a) the importance of curriculum reforms to favor progress on science and innovation; b) the emergence of a program to favor access in HE for non-traditional students (e.g., students from disadvantaged sectors of the population); and, c) the crisis in educating and recruiting engineering students since school years. These agendas might be an opportunity for writing and communication advocates to lead initiatives in engineering majors in which, as the analysis of the Colombian news suggests, there are cases in which language and writing is regarded as a “basic” ability promoted by curricula, but also expectations on writing a senior thesis for degree completion, which is a high stake writing task.

F. Conclusion

This chapter reviews literature on technological innovation and economic growth in Latin America and chronologically analyzes online news on national engineering from the two oldest newspapers in a developing country, Colombia. This analysis provided a context to propose research agendas on Technical Communication for a Latin-American country. Since in Latin America there is no specific field equivalent to Technical Communication as developed in the U.S., a literature review of the U.S. scholarship has been used to frame such agenda while discussing the literature on technological innovation and economic growth in Latin America and the chronological analysis of online news on Colombian engineering with special attention to implications on learning writing, language, and communication.

The analysis suggests that English competencies or even learning other foreign languages, intercultural communication knowledge for business, and research writing (either for degree completion or for research and technological innovations) are some of the learning expectations emerging from Colombian engineering education. This analysis also reveals that engineers of developing economies might be exposed and "enculturated" under communicative practices of "price takers", which may imply language practices undermining opportunities for negotiation and argumentation. This hypothesis might be further tested by conducting studies on communicative practices of business negotiations between Colombian and foreign entrepreneurs.

Furthermore, the analysis offers a list of business and research organizations/associations that might be interesting research sites in Colombia to explore technical communication practices (appendix 9), particularly those related to technology transfer (e.g., patent production and legalization) and public communication of science (especially, risk communication associated with natural resource-processing industries) because of the features of the Latin-American economic sector and the current Colombian public interests in technology and innovation (e.g., the emphasis in the computer science subfield, and science-oriented reforms for elementary, secondary, and higher education to recruit more future engineers and non-traditional students). Additionally, this analysis uncovers a Colombian higher education reform favoring access for students from disadvantaged sectors of the population who are enrolling in engineering majors, which might bring to the fore the need of interdisciplinary conversations between associations/organizations related to engineering education and writing advocates who are familiar with educational challenges for non-traditional students.

This chapter contributes with insights upon the engineering knowledge production and its implications for engineering education, especially expectations on engineering writing and communication from a "local approach" (Chambers & Gillespie, 2000) by creating accounts from online newspapers of a developing country, Colombia. Therefore, this analysis has shed light on research sites that, at least, in the Colombian case might inform about the teaching contents for emergent programs of technical communication. The analysis also provides information to the International field on Writing Studies to add nuances about what counts as technical communication knowledge in the U.S., and thus inform curriculum decisions in technical communication programs especially in graduate education since, as the data suggests, studying overseas and getting opportunities for multinational internships are current professional opportunities for practitioners in engineering of developing countries such as Colombia.

Appendix 1
Data base of the news

#	Year	News title	Link	Newspaper	Type of news
1	1991	UNA EMPRESA CON RUMBO PROPIO An Own-leading Enterprise	http://www.eltiempo.com/archivo/documento/MAM-179617	El Tiempo	News on awards
2	1993	INGENIERIA ESTRUCTURAL: Structural Engineering	http://www.eltiempo.com/archivo/documento/MAM-203094	El Tiempo	News on academic events
3	1993	INGENIERIA MEJOR ESTRUCTURADA Better Structured Engineering	http://www.eltiempo.com/archivo/documento/MAM-197995	El Tiempo	News on academic events
4	1993	XIII REUNION NACIONAL DE FACULTADES DE INGENIERIA: XII National Reunion of Engineering Faculties	http://www.eltiempo.com/archivo/documento/MAM-265758	El Tiempo	News on academic events
5	1993	TALLER DE ENSAMBLAJE DE MICROS: Micros Assembly Workshop	http://www.eltiempo.com/archivo/documento/MAM-100613	El Tiempo	News on academic events
6	1993	SE UNEN INGENIEROS MILITARES Y CIVILES Military and Civil Engineers Get Together	http://www.eltiempo.com/archivo/documento/MAM-234896	El Tiempo	News on academic events
7	1994	INGENIERIA DE INFORMACION: Systems Engineering	http://www.eltiempo.com/archivo/documento/MAM-202442	El Tiempo	News on academic events
8	1994	INGENIERIA QUIMICA: Chemical Engineering	http://www.eltiempo.com/archivo/documento/MAM-169069	El Tiempo	News on academic events
9	1994	INGENIERIA Y COMUNICACIONES Engineering and Communications	http://www.eltiempo.com/archivo/documento/MAM-228805	El Tiempo	News on academic events
10	1994	INGENIERIA SEMINARIO DE HUIDRAULICA Engineering, Hydraulic Seminar	http://www.eltiempo.com/archivo/documento/MAM-147026	El Tiempo	News on academic events
11	1994	INGENIERIA DE SOFTWARE ASISTIDA POR COMPUTADOR Computer Assisted Software Engineering	http://www.eltiempo.com/archivo/documento/MAM-59203	El Tiempo	News on academic events
12	1994	INGENIERIA DE SISTEMAS EN LA JAVERIANA Systems Engineering in La Javeriana University	http://www.eltiempo.com/archivo/documento/MAM-238008	El Tiempo	News on college programs and students innovations
13	1994	INGENIERIA CONGRESO GREMIAL Engineering, Trade Congress	http://www.eltiempo.com/archivo/documento/MAM-112803	El Tiempo	News on academic events

14	1994	POSTGRADO EN INGENIERIA DE SOFTWARE: Software Engineering Postgraduate Studies	http://www.eltiempo.com/archivo/documento/MAM-28816	El Tiempo	News on college programs and students innovations
15	1994	POSTGRADO EN INGENIERIA DE SOFTWARE Software Engineering Postgraduate Studies	http://www.eltiempo.com/archivo/documento/MAM-59238	El Tiempo	News on college programs and students innovations
16	1994	LA FACULTAD DE INGENIERIA DE SISTEMAS Systems Engineering Faculty	http://www.eltiempo.com/archivo/documento/MAM-123122	El Tiempo	News on academic events
17	1995	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-362989	El Tiempo	News on academic events
18	1995	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-421500	El Tiempo	News on academic events
19	1995	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-448472	El Tiempo	News on academic events
20	1995	INGENIERIA ELECTRICA Electric Engineering	http://www.eltiempo.com/archivo/documento/MAM-427183	El Tiempo	News on academic events
21	1995	INGENIERIA ESTRUCTURAL Structural Engineering	http://www.eltiempo.com/archivo/documento/MAM-330828	El Tiempo	News on academic events
22	1995	LA FACULTAD DE INGENIERIA The Engineering Faculty	http://www.eltiempo.com/archivo/documento/MAM-425902	El Tiempo	News on academic events
23	1995	INGENIERIA ESTRUCTURAL.: Structural Engineering	http://www.eltiempo.com/archivo/documento/MAM-323572	El Tiempo	News on academic events
24	1995	LA INGENIERIA NAVAL Marine Engineering	http://www.eltiempo.com/archivo/documento/MAM-439540	El Tiempo	News on college programs and students innovations
25	1995	LA FACULTAD DE INGENIERIA The Engineering Faculty	http://www.eltiempo.com/archivo/documento/MAM-425952	El Tiempo	News on academic events
26	1996	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-517025	El Tiempo	News on academic events
27	1996	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-313429	El Tiempo	News on academic events
28	1996	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-441617	El Tiempo	News on academic events
29	1996	INGENIERIA Engineering	http://www.eltiempo.com/archivo/documento/MAM-461281	El Tiempo	News on academic events
30	1997	DOCTORADO EN INGENIERIA QUIMICA Chemical Engineering Doctorate	http://www.eltiempo.com/archivo/documento/MAM-640127	El Tiempo	News on college programs and students innovations

31	1997	PROFESIONALES CON CRITERIO Discerning Professionals	http://www.eltiempo.com/archivo/documento/MAM-641820	El Tiempo	News on college programs and students innovations
32	1997	AHORA, A PRODUCIR FRUTAS CUADRADAS Now It's Time to Produce Square Fruits	http://www.eltiempo.com/archivo/documento/MAM-598532	El Tiempo	News on technological innovation
33	2001	INGENIERIA DE MINAS. UN VIAJE AL CENTRO DE LA TIERRA Mining Engineering. A Journey to the Center of the Earth	http://www.eltiempo.com/archivo/documento/MAM-577289	El Tiempo	News on college programs and students innovations
34	2001	INGENIERIA INDUSTRIAL. MUCHO MÁS QUE EMPRESARIOS Industrial Engineering, Much More Than Just Businessmen	http://www.eltiempo.com/archivo/documento/MAM-577258	El Tiempo	News on college programs and students innovations
35	2001	INGENIERIA DE TELECOMUNICACIONES. EXPERTOS EN INTEGRACIÓN DE SISTEMAS Telecommunications Engineering. Systems Integration Experts	http://www.eltiempo.com/archivo/documento/MAM-577223	El Tiempo	News on college programs and students innovations
36	2001	INGENIERIA ELECTRONICA Y DE TELECOMUNICACIONES. CREADORES DE TECNOLOGÍA ÚTIL Electronic and Telecommunication Engineering. Helpful Technology Creators.	http://www.eltiempo.com/archivo/documento/MAM-577276	El Tiempo	News on college programs and students innovations
37	2001	ESTUDIOS DIRIGIDOS E INGENIERIA GENERAL. OPCIONES, MIENTRAS DECIDE Followed-up Studies and General Engineering. Meanwhile Options.	http://www.eltiempo.com/archivo/documento/MAM-578362	El Tiempo	News on college programs and students innovations
38	2001	LOS IMPULSORES DE LA AVIACIÓN MODERNA Modern Aviation Promoters	http://www.eltiempo.com/archivo/documento/MAM-686374	El Tiempo	News on college programs and students innovations
39	2001	PARA QUIEN GUSTA DE LAS MÁQUINAS For Those Who Love Machines	http://www.eltiempo.com/archivo/documento/MAM-686279	El Tiempo	News on college programs and students innovations
40	2001	BUEN FUTURO, SIN COMPETENCIA A Promising Future Without Competence	http://www.eltiempo.com/archivo/documento/MAM-686347	El Tiempo	News on college programs and students innovations
41	2001	LOS DUEÑOS DEL FUTURO The Future's Owners	http://www.eltiempo.com/archivo/documento/MAM-686397	El Tiempo	News on college programs and students innovations
42	2001	SE CONSOLIDA INGENIERÍA NAVAL Marine Engineering is Strengthened	http://www.eltiempo.com/archivo/documento/MAM-446763	El Tiempo	News on college programs and students innovations

43	2003	PRIMERA FACULTAD DE INGENIERIA DEL PAIS CUMPLE 60 AÑOS The First Engineering Faculty of the Country is Now 60 Years Old	http://www.eltiempo.com/archivo/documento/MAM-995650	El Tiempo	News on college programs and students innovations
44	2004	INGENIERIA FUTURISTA: Futuristic Engineering	http://www.eltiempo.com/archivo/documento/MAM-1538716	El Tiempo	News on college programs and students innovations
45	2008	Nanomedicina contra el cáncer Nanomedicine Against Cancer	http://www.elespectador.com/impreso/vivir/articuloimpreso-nanomedicina-contra-el-cancer	El Espectador	News on technological innovation
46	2008	Estudiante colombiana participa en el Congreso mundial de Ingeniería A Colombian Student Participates in the World Engineering Congress	http://www.elespectador.com/noticias/actualidad/articulo-estudiante-colombiana-participa-el-congreso-mundial-de-ingenieria	El Espectador	News on awards
47	2008	Tecnología para la salud Technology for the Health	http://www.elespectador.com/noticias/salud/articulo-tecnologia-salud	El Espectador	News on academic events
48	2010	El hombre estructural The Structural Man	http://www.elespectador.com/impreso/negocios/articuloimpreso-241147-el-hombre-estructural	El Espectador	News on awards
49	2015	Ganado a la criolla Criollo Cattle	http://www.elespectador.com/especiales/ganado-criolla-articulo-551297	El Espectador	News on technological innovation
50	2015	La academia, con las botas puestas The Academy Put on Its Boots	http://www.elespectador.com/noticias/nacional/academia-botas-puestas-articulo-551287	El Espectador	News on college programs and students innovations
51	2015	Injertos que salvan Saviour Grafts	http://www.elespectador.com/especiales/injertos-salvan-articulo-551054	El Espectador	News on technological innovation
52	2015	Los retos de la sociedad del conocimiento en Colombia The Society Challenges of Knowledge in Colombia	http://www.elespectador.com/noticias/educacion/los-retos-de-sociedad-del-conocimiento-colombia-articulo-550902	El Espectador	News on international treaties and policies
53	2015	Ser pilo paga: ¿y las públicas qué? Ser Pilo Paga: What About Public Institutions?	http://www.elespectador.com/noticias/educacion/ser-pilo-paga-y-publicas-articulo-550899	El Espectador	News on college programs and students innovations
54	2015	“La gente no quiere estudiar ingeniería” “People Do Not Want to Study Engineering”	http://www.elespectador.com/noticias/economia/gente-no-quiere-estudiar-ingenieria-articulo-543544	El Espectador	News on college programs and students innovations
55	2015	Colombia busca aumentar su influencia en la industria naval latinoamericana Colombia Is Trying to Increase Its Influence in the Latin American Marine Industry	http://www.elespectador.com/noticias/nacional/colombia-busca-aumentar-su-influencia-industria-naval-l-articulo-548840	El Espectador	News on technological innovation

56	2015	Estudiantes de la U. Nacional desarrollan máquina que impregna de nutrientes a las frutas Students of the National University Develop a Machine that Fills Fruits With Nutrients	http://www.elespectador.com/noticias/nacional/estudiantes-de-u-nacional-desarrollan-maquina-impregna-articulo-548892	El Espectador	News on college programs and research or students innovations
57	2015	Gobierno anuncia alianza para agrupar empresas del sector defensa The Government Annunciates an Alliance to Group up Enterprises From the Defense Sector	http://www.elespectador.com/noticias/nacional/gobierno-anuncia-alianza-agrupar-empresas-del-sector-de-articulo-548848	El Espectador	News on technological innovation
58	2015	Modernizan redes de alcantarillado para prevenir inundaciones en Bogotá Sewage Networks Are Modernized to Prevent Floods in Bogotá	http://www.elespectador.com/noticias/bogota/modernizan-redes-de-alcantarillado-prevenir-inundacione-articulo-549079	El Espectador	News on technological innovation
59	2015	Colombiamar perfila al país como alternativa mundial de bienes y servicios navales Colombiamar Puts the Country as a World Alternative of Assets and Services	http://www.elespectador.com/noticias/economia/colombiamar-perfila-al-pais-alternativa-mundial-de-bien-articulo-549306	El Espectador	News on technological innovation
60	2015	El metro ligero en la 7ª se desvanece The Light Metro in the 7th Street Fades Away	http://www.elespectador.com/noticias/bogota/el-metro-ligero-7a-se-desvanece-articulo-548645	El Espectador	News on technological innovation
61	2015	Matemática, la herramienta de esta científica colombiana contra la contaminación de ríos Mathematics, this Colombian Scientific's Tool Against Rivers Pollution	http://www.elespectador.com/noticias/medio-ambiente/matematica-herramienta-de-esta-cientifica-colombiana-co-articulo-548784	El Espectador	News on college programs and research or students innovations
62	2015	Canadá busca colombianos dispuestos a trabajar Canada Looks for Colombians Willing to Work	http://www.elespectador.com/noticias/actualidad/canada-busca-colombianos-dispuestos-trabajar-articulo-547226	El Espectador	News on international treaties and policies
63	2015	El arroyo que se le atravesó al Cerrejón The Stream that Got Into the Cerrejón's Way	http://www.elespectador.com/noticias/medio-ambiente/el-arroyo-se-le-atraveso-al-cerrejon-articulo-548145	El Espectador	News on technological innovation
64	2015	Ericsson abre convocatoria de pasantías para profesionales en Colombia Ericsson Launches Internship Convocation for Professionals in Colombia	http://www.elespectador.com/noticias/educacion/ericsson-abre-convocatoria-de-pasantias-profesionales-c-articulo-545948	El Espectador	News on research grants
65	2015	Abren convocatoria para ser tutor del Programa 'Todos a Aprender' Open Call for the Program "Todos a Aprender"	http://www.elespectador.com/noticias/educacion/abren-convocatoria-ser-tutor-del-programa-todos-aprende-articulo-546347	El Espectador	News on research grants

66	2015	El optimismo de los arquitectos e ingenieros colombianos The Colombian Architects and Engineers Optimism	http://www.elespectador.com/noticias/economia/el-optimismo-de-los-arquitectos-e-ingenieros-colombiano-articulo-545335	El Espectador	News on college programs and research or students innovations
67	2015	Energías renovables con petróleo barato Renewable Energies With Cheap Oil	http://www.elespectador.com/noticias/economia/energias-renovables-petroleo-barato-articulo-545621	El Espectador	News on international treaties and policies
68	2015	¿Les cogió la noche con el inglés a los estudiantes de La Salle? Are the La Salle University Students Delayed in the English Learning?	http://www.elespectador.com/noticias/educacion/les-cogio-noche-el-ingles-los-estudiantes-de-salle-articulo-544799	El Espectador	News on college programs and research or students innovations
69	2015	“La innovación es ante todo actitud” “Innovation Is Attitude”	http://www.elespectador.com/noticias/actualidad/innovacion-todo-actitud-articulo-544018	El Espectador	News on technological innovation
70	2015	“Vinimos a aprender de Colombia” “We Came to Learn From Colombia”	http://www.elespectador.com/noticias/economia/vinimos-aprender-de-colombia-articulo-542144	El Espectador	News on international treaties and policies
71	2015	Migración y bajos salarios, realidad de ingenieros químicos según expertos de la U. Nacional According to the National University Experts, Migration and Poor Salaries are the Reality Chemical Engineers Face	http://www.elespectador.com/noticias/nacional/migracion-y-bajos-salarios-realidad-de-ingenieros-quimi-articulo-538878	El Espectador	News on college programs and research or students innovations
72	2015	La Salle, la universidad que más becarios recibió La Salle, the University With More Grant Holders	http://www.elespectador.com/noticias/educacion/salle-universidad-mas-becarios-recibio-articulo-539480	El Espectador	News on college programs and research or students innovations
73	2015	Ser Pilo Paga, un gran experimento *Ser Pilo Paga*, a Great Experiment	http://www.elespectador.com/noticias/educacion/ser-pilo-paga-un-gran-experimento-articulo-539804	El Espectador	News on college programs and research or students innovations
74	2015	Universidades más caras, ¿la mejor decisión? The Most Expensive Universities, the Best Option?	http://www.elespectador.com/noticias/educacion/universidades-mas-caras-mejor-decision-articulo-539304	El Espectador	News on college programs and research or students innovations
75	2015	Mintic abre convocatorias para formación de profesionales en Tecnologías de la Información Mintic Makes a Call for Educating Professionals in Information Technologies	http://www.elespectador.com/noticias/nacional/mintic-abre-convocatorias-formacion-de-profesionales-te-articulo-538694	El Espectador	News on research grants
76	2015	Apuesta energética Energetic bet	http://www.elespectador.com/noticias/economia/apuesta-energetica-articulo-538136	El Espectador	News on technological innovation
77	2015	Sin cables ni contraseñas No Need of Wires or Passwords	http://www.elespectador.com/noticias/economia/sin-cables-ni-contrasenas-articulo-538375	El Espectador	News on technological innovation

78	2015	¿Ser o no ser el Silicon Valley latino? To Be or Not to Be the Latin Silicon Valley?	http://www.elespectador.com/noticias/economia/ser-o-no-ser-el-silicon-valley-latino-articulo-537707	El Espectador	News on technological innovation
79	2015	Expertos detectan nueva plaga que causa daños a cultivos de aguacate en el país Experts Detect the New Plague that Damages Avocadoes Crops in the Country	http://www.elespectador.com/noticias/nacional/expertos-detectan-nueva-plaga-causa-danos-cultivos-de-a-articulo-537152	El Espectador	News on college programs and research or students innovations
80	2015	Estudiante en Manizales diseña prototipo para cargar dispositivos móviles pedaleando A Student in Manizales Designs a Prototype for Charging Mobile Devices By Pedaling	http://www.elespectador.com/noticias/actualidad/estudiante-manizales-disena-prototipo-cargar-dispositiv-articulo-535870	El Espectador	News on college programs and research or students innovations
81	2015	Curso de fabricación de cerveza en la U. Nacional para 'fomentar consumo responsable' Beer Manufacturing in the National University to "Foster Responsible Consumption"	http://www.elespectador.com/noticias/actualidad/curso-de-fabricacion-de-cerveza-u-nacional-fomentar-con-articulo-535842	El Espectador	News on college programs and research or students innovations

Appendix 2
List of the organizations/associations organized by foundation date and years in existence from oldest to youngest

# of the case	Name of organization	Dates	Years in existence
11	Escuela Colombiana de Ingenieros Militares Military Engineers Colombian School	1814	201
2	la Sociedad Colombiana de Ingenieros (SCI) The Engineers Colombian Society (SCI)	1887	128
18	Industria Militar de Colombia Colombia Military Industry	1908	107
12	Facultad de Ingeniería de la Universidad de Antioquía University of Antioquia Engineering Faculty	1943	72
13	Facultad de Ingeniería de la Universidad de Antioquía University of Antioquia Engineering Faculty	1943	72
23	ANDI - Asociación Nacional de Empresarios de Colombia ANDI – Colombia Businessmen National Association	1944	71
27	Ingetec Ingetec	1950	65
14	Asociación Colombiana de Hospitales y Clínicas Hospitals and Clinics Colombian Association	1955	60
39	Banco Interamericano de Desarrollo Inter-American Bank of Development	1959	56
31	World Wide Fund for Nature-Colombia	1960	55
33	Ecopetrol	1961	54
40	Organización para la Cooperación y el Desarrollo Económicos (OCDE) Organization for the Economic Cooperation and Development	1961	54
8	Instituto Colombiano Agropecuario Colombian Agricultural Institute	1962	53
1	Asociación Colombiana de Facultades de Ingeniería Colombian Association of Engineering Faculties	1966	49
16	Colciencias - Colombia Colcienncias – Colombia	1968	47
7	Asociación Colombiana de Ingeniería Sísmica Earthquake Engineering Colombian Association	1975	40

28	Corpoguajira Corpoguajira	1983	32
29	Asociación Centro Nacional Salud, Ambiente y Trabajo (Censat) Association of National Center in Health, Environment, and Labour (Censat)	1989	26
32	El Centro de Investigaciones en Ingeniería Ambiental de la Universidad de los Andes The Environmental Engineering Research Center of Los Andes University	1991	24
5	Banco Colombiano de Comercio Exterior (Bancoldex) Foreign Trade Colombian Bank (Bancoldex)	1991	24
38	Isagen Isagen	1992	23
26	Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia - IDEAM Hydrology, Meteorology and Environmental Studies Colombian Institute - IDEAM	1993	22
19	Invima (Instituto Nacional de Vigilancia de Medicamentos y Alimentos) Invima (Drugs and Food Vigilance National Institute)	1994	21
9	La Corporación Colombiana de Investigación Agropecuaria (Corpoica) Colombian Corporation of Agricultural Investigation (Corpoica)	1995	20
10	La Corporación Colombiana de Investigación Agropecuaria (Corpoica) Colombian Corporation of Agricultural Investigation (Corpoica)	1995	20
21	Fedesoft | La Federación Colombiana de la Industria del Software y Tecnologías Informáticas (Fedesoft) Colombian Federation of Software and Systems Technologies Industry	1999	16
4	Asociación Colombiana de Usuarios de Internet ACUI Colombian Association of Internet Users (ACUI)	2000	15
30	Structuralia Structuralia	2001	14
3	Asociación Colombiana de Ingenieros Constructores (ACIC) Colombian Association of Constructor Engineers	2003	12

15	Cámara Colombiana de la Infraestructura (CCI) Colombian Chamber of Infrastructure (CCI)	2003	12
34	Agencia Nacional de Infraestructura (ANI) de Colombia Colombian Infrastructure Agency (ANI)	2003	12
36	Observatorio Laboral del Ministerio de Educación Labor- market Observatory of The Ministry of Education	2005	10
6	Asociación Colombiana de Usuarios de Computadores [de usuarios de Internet] Colombian Association of Computer Users [Internet users]	2007	8
22	la Corporación de Ciencia y Tecnología para el Desarrollo de la Industria Naval, Marítima y Fluvial (Cotecmar) Science and Technology Corporation for the Development of the Marine, Maritime and Fluvial Industry (Cotecmar)	2009	6
37	El Ministerio de Tecnologías de la Información y las Comunicaciones The Ministry of Information Technology and Communications	2009	6
17	Wayra	2011	4
20	Ser pilo paga - Ministerio de Educación Nacional Program “Ser pilo paga”- Ministry of Education	2014	1

Appendix 3
List of the organizations that are business-oriented and research-oriented organized by foundation date from oldest to youngest

# of the case	Name of organization	Link	Dates	Years in existence
11	Escuela Colombiana de Ingenieros Militares Military Engineers Colombian School	http://www.esing.mil.co/	1814	201
2	la Sociedad Colombiana de Ingenieros (SCI) The Engineers Colombian Society (SCI)	http://www.sci.org.co/sci/historia.page	1887	128
18	Industria Militar de Colombia Colombia Military Industry	https://www.indumil.gov.co/	1908	107
12	Facultad de Ingeniería de la Universidad de Antioquía University of Antioquia Engineering Faculty	http://portal.udea.edu.co/wps/portal/udea/web/inicio/institucional/unidades-academicas/facultades/ingenieria/ingenieria	1943	72
13	Facultad de Ingeniería de la Universidad de Antioquía University of Antioquia Engineering Faculty	http://portal.udea.edu.co/wps/portal/udea/web/inicio/institucional/unidades-academicas/facultades/ingenieria/ingenieria	1943	72
23	ANDI - Asociación Nacional de Empresarios de Colombia ANDI – Colombia Businessmen National Association	http://www.andi.com.co/	1944	71
27	Ingetec Ingetec	http://www.ingetec.com.co/index.php?lang=en	1950	65
14	Asociación Colombiana de Hospitales y Clínicas Hospitals and Clinics Colombian Association	http://www.achc.org.co/contenidos.php?idcat=11	1955	60
39	Banco Interamericano de Desarrollo Inter-American Bank of Development	http://www.iadb.org/en/inter-american-development-bank,2837.html	1959	56
40	Organización para la Cooperación y el Desarrollo Económicos (OCDE) Organization for the Economic Cooperation and Development	http://www.oecd.org/	1961	54
8	Instituto Colombiano Agropecuario Colombian Agricultural Institute	http://www.ica.gov.co/El-ICA/Historia.aspx	1962	53
1	Asociación Colombiana de Facultades de Ingeniería Colombian Association of Engineering Faculties	http://www.acofi.edu.co/	1966	49
16	Colciencias - Colombia Colcienncias – Colombia	http://www.colciencias.gov.co/	1968	47
7	Asociación Colombiana de Ingeniería Sísmica Earthquake Engineering Colombian Association	http://www.asosismica.org.co/?idcategoria=1051	1975	40
28	Corpoguajira Corpoguajira	http://corpoguajira.gov.co/	1983	32

29	Asociación Centro Nacional Salud, Ambiente y Trabajo (Censat) Association of National Center in Health, Environment, and Labour (Censat)	http://censat.org/	1989	26
32	El Centro de Investigaciones en Ingeniería Ambiental de la Universidad de los Andes The Environmental Engineering Research Center of Los Andes University	https://ciia.uniandes.edu.co/	1991	24
5	Banco Colombiano de Comercio Exterior (Bancoldex) Foreign Trade Colombian Bank (Bancoldex)	http://www.bancoldex.com/acerca-de-nosotros92/Historia.aspx	1991	24
38	Isagen Isagen	https://www.isagen.com.co/	1992	23
26	Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia - IDEAM Hydrology, Meteorology and Environmental Studies Colombian Institute - IDEAM	http://www.icde.org.co/web/guest/ideam	1993	22
19	Invima (Instituto Nacional de Vigilancia de Medicamentos y Alimentos) Invima (Drugs and Food Vigilance National Institute)	https://www.invima.gov.co/	1994	21
9	La Corporación Colombiana de Investigación Agropecuaria (Corpoica) Colombian Corporation of Agricultural Investigation (Corpoica)	http://www.corpoica.org.co/SitioWeb/	1995	20
10	La Corporación Colombiana de Investigación Agropecuaria (Corpoica) Colombian Corporation of Agricultural Investigation (Corpoica)	http://www.corpoica.org.co/SitioWeb/	1995	20
21	Fedesoft | La Federación Colombiana de la Industria del Software y Tecnologías Informáticas (Fedesoft) Colombian Federation of Software and Systems Technologies Industry	http://fedesoft.org/	1999	16
4	Asociación Colombiana de Usuarios de Internet ACUI Colombian Association of Internet Users (ACUI)	http://www.ane.gov.co/index.php/conozca-la-ane/directorios/directorio-de-asociaciones/acui-asociacion-colombiana-de-usuarios-de-internet-acui.html	2000	15
30	Structuralia Structuralia	http://www.structuralia.com/lat/	2001	14
3	Asociación Colombiana de Ingenieros Constructores (ACIC) Colombian Association of Constructor Engineers	http://www.infraestructura.org.co/index.php?id=2&ide=131&id_seccion=&ellado=1	2003	12

22	la Corporación de Ciencia y Tecnología para el Desarrollo de la Industria Naval, Marítima y Fluvial (Cotecmar) Science and Technology Corporation for the Development of the Marine, Maritime and Fluvial Industry (Cotecmar)	http://www.cotecmar.com/	2009	6
25	The International Ship Design and Naval Engineering Congress (ISDNEC)	http://cidin.co/index.php/cidin/2015	NA	
24	IV Feria Internacional de la Industria Naval IV International Fair of the Marine Industry	http://colombiamar.co/feria/	NA	
25	The International Ship Design and Naval Engineering Congress (ISDNEC)	http://cidin.co/index.php/cidin/2015	NA	
35	Departamento Nacional de Planeación Planning National Department	https://www.dnp.gov.co/Paginas/inicio.aspx		

III. Chapter 3. Disciplinary expectations on writing and communication in a Colombian major in Industrial Engineering: an exploration through syllabi

Abstract

Colombian undergraduate students developed their writing abilities without institutionalized systematic teaching initiatives across their majors. Furthermore, current public policies in Colombia for the advancement of science, technology, and innovation fuel the advancement of engineering; however, Latin-American initiatives and studies in engineering writing and communication of Spanish-Speaking countries are emerging, focused on engineering as one field, and it is not frequent to consider writing/language as a multimodal phenomenon. Therefore, this chapter offers insights that might inform writing curriculum design in a specific engineering subfield, Industrial Engineering, by including expectations of verbal and non-verbal writing (e.g., graphics, tables, or pics) and communication over time. Two types of data have been analyzed: a) Faculty members' expectations regarding conducting and writing a senior thesis; and, b) Disciplinary learning expectations of ways of doing and thinking with special attention to writing and communication including non-verbal expectations that are stated through syllabi. The analysis suggests that students are expected to integrate linguistic and non-linguistic resources to convey their professional performance in senior theses to make decisions, lead, and propose institutional changes in companies to improve processes and profits of organizations. The analysis of the syllabi overall reveals that writing and other semiotic systems emerge as part of ways of doing (methodologies), and ways of thinking (ideologies) that engage students in different writing epistemologies that might become contradictory (e.g., one system that is valuing meaning creation by negotiating with others, and the other one that is emphasizing standards/protocols and conventions); however, the tendency is to utilize writing primarily related to solving problems by standardizing processes in companies and aiming at achieving profitability and productivity in such organizations. The type of genre "report" seems to be the most frequent format that embraces these systems of values. Furthermore, the analysis of writing presence for learning and assessing in the courses suggests that students are not necessarily exposed to explicit assessment practices that make them to gain awareness of the expectations, including expectations on learning/developing semiotic systems of representations other than verbal systems that should be repurposed in conducting their senior theses.

A. Introduction

Colombian programmatic initiatives that advocate teaching of reading and writing in Higher Education have carried out since 2000. An inter-institutional research project conducted by 17 universities between 2009 and 2011 confirms that the most overt institutional policy is to offer one or two freshman composition courses in Spanish (Rincón, Pérez-Abril et al., 2013). This study also included 20 case studies of outstanding practices for teaching reading and writing across the 17 participating universities, the analysis of these cases showed that most of these experiences were led by disciplinary professors whose academic trajectories and commitments had impacted positively their pedagogical practices; thus, they had decided offering scaffolding to student learning through reading and writing (Rincón, Pérez-Abril et al., 2013). Despite these outstanding teaching experiences identified in the study, the overall tendency is that writing initiatives were not necessarily part of writing programs or other institutional endeavors, except for two cases. Consequently, Colombian undergraduate students, at least those who belong to the 17 participating universities, developed their writing abilities without institutionalized systematic teaching initiatives across their majors.

Current public policies in Colombia for the advancement of science, technology, and innovation are funding PhD education for engineers overseas as part of a commitment to national progress. In the next decades, PhD Colombian engineers will fuel the advancement of their field and academic programs; therefore, conducting research projects concerning disciplinary writing expectations in engineering programs is a fruitful research site to spur larger debates among the advocates of teaching writing in higher education on how and why envisioning writing disciplinary curricula.

The analysis of 22 publications on Latin-American initiatives and studies in engineering writing and communication of Spanish Speaking countries shows that systematic endeavors (teaching and research) are recent in the region, since 2009. These undertakings seem to have been focused on engineering as one field; thus, further studies are needed to explore disciplinary writing variation by subfields in engineering (e.g., mechanical engineering, biomedical engineering, industrial engineering). Furthermore, despite there are Latin-American studies and initiatives that consider writing/language as a multimodal phenomenon (cf. Añino et al. 2010; 2012; 2013, and Parodi, 2010), it is not frequent.

Consequently, this chapter offers insights that might inform writing curriculum design in a specific engineering subfield by including expectations of verbal and non-verbal writing (e.g., graphics, tables, or pics) and communication over time. Two types of data have been analyzed:

a) Faculty members' expectations regarding conducting and writing a senior thesis, since this is the most ambitious writing project students need to address in this undergraduate curriculum; and,

b) Disciplinary learning expectations of ways of doing and thinking with special attention to writing and communication including non-verbal expectations (e.g., graphics, tables, or pics) that are stated by the instructors through syllabi (by semesters and by curriculum years, namely, freshman, sophomore, junior, and senior).

Since the analysis aims at identifying disciplinary expectations on writing and communication in a major of Industrial Engineering over time within curriculum, this chapter presents a literature review describing an approach that links disciplinary learning and instruction. This approach was useful to create the grounded categories of the analysis. Additionally, a literature review on curriculum endeavors beyond first year composition courses (FYC) is summarized to later discuss the analysis. Contexts of data collection are also presented by describing features of the region, the institution, and the engineering major. Later, data are reported in two portions:

i) faculty members' expectations regarding conducting and writing a senior thesis; and,

ii) disciplinary learning expectations for writing and communication including non-verbal expectations (e.g., graphics, tables, or pics) that are stated through syllabi (by semesters and by curriculum years, namely, freshman, sophomore, junior, and senior).

B. Literature review on disciplinary learning and curriculum endeavors beyond first year composition

Since the analysis aims at identifying disciplinary expectations on writing and communication in a major of Industrial Engineering over time, the first part of the literature review describes an approach that links disciplines, learning, and instruction. This approach was useful to justify and create the grounded categories of the analysis to identify ways of doing and thinking of the engineering subfield in general and those especially related to writing and communication.

The second part summarizes a literature review on curriculum endeavors beyond first year composition courses (FYC), which will be used to later discuss the analysis to offer insights that might inform writing curriculum design in a specific engineering subfield by including expectations of verbal and non-verbal writing and communication over time. This literature review also informed the grounded categories utilized in the analysis.

1. Disciplinary learning and instruction

The student movement from the cultural knowledge acquired through learning experiences other than the schooling situations (everyday knowledge) toward the cultural knowledge provided by instruction (knowledge constructed by academic communities) counts as development. “A mature concept” is achieved when scientific/academic reasoning and everyday knowledge merge to impose ways of reasoning of scientific/academic knowledge provided by curriculum experiences. This means that scientific concepts are sophisticated knowledge emerging from disciplinary/academic communities; therefore, development or growth is considered as the changes in reasoning by learning scientific knowledge throughout curriculum experiences.

In higher education, the pedagogical theory of threshold concepts sheds light on what counts as development as the influence of instruction, since threshold concepts are descriptions of disciplinary learning knowledge that must be mastered by students to acquire disciplinary reasoning. Threshold concepts are troublesome knowledge that has important transformative effects on student understanding. They are conceptual gateways toward more advanced ways of thinking that were inaccessible before learning about them (Meyer, 2008); consequently, threshold concepts are necessary for students to progress according to learning expectations throughout subject matters and curricula (Baillie & Johnson, 2008; Meyer & Land, 2013).

Acquiring threshold concepts is a developmental process. The following stages have been used to describe students' transitions: a) In a preliminary stage, tacit views of learners (everyday knowledge) start to be interrupted by initial comprehension of threshold concept (scientific knowledge); b) In a liminal stage, the learner becomes aware of the threshold concept; and, c) In a postliminal stage, the learner is transformed and begins to think as a member of the field in which the threshold concept is situated (Adler-Kassner, Majewski & Koshnick, 2012). The same person can navigate between liminal and postliminal stages and be stuck while learning threshold concepts; since threshold concepts are learned through specific disciplinary language, threshold concepts are acquired if students have also developed ownership of concepts, which is to mastering them as discourse entities (e.g., knowledge domains constructed by language). These transformations in learning threshold concepts and its disciplinary language can oscillate among the stages and even have temporary regressions (Meyer & Land, 2013).

Learners have to experiment with variations of learning experiences to acquire threshold concepts and thus be able to make generalizations (i.e., drawing conclusions that will be used as “the knowledge” to face new learning experiences). This means that students need to learn disciplinary language of threshold concepts and it diverse situations as means to solve disciplinary problems with “the knowledge” they have acquired (Meyer, 2008). Therefore, to acquire threshold concepts, core concepts have to be learned as well; core concepts are content knowledge as platforms that do not lead to qualitative changes of reasoning in a subject matter but provide disciplinary language (Meyer & Land, 2013); therefore, a threshold concept is broader category than a core concept since the latter is necessary to acquire the first (Meyer, 2008). For instance, in the field of Writing Studies a core concept might be “audiences”; however, a threshold concept might be to understand the relationship between audiences and rhetorical circumstances. Since threshold concepts are types of learning expectations held by instructors, threshold concepts might be explored through syllabi (Meyer, 2008).

This pedagogical theory, furthermore, acknowledges that interpreting learning experiences by students draws on personal prior knowledge about the subject matter and assumptions about knowledge and learning. Instructional environments therefore should seek different strategies to facilitate students to acquire threshold concepts from different experiences such as applying the concepts to real world problems, or making visible certain disciplinary terms as an aid of discernment (by underlining or enlarging fonts in texts) to help students to make sense; otherwise, learning objects (threshold concepts, for instance, such as imaginary numbers) will be seen as absurd categories that are difficult to grasp just by lecturing (Meyer et al., 2008).

Although threshold concepts reinforces the importance of linking disciplinary learning and instruction, developing a strong disciplinary education by mainly teaching threshold concepts of a specific community might progressively diminish the ability to see variations across disciplinary communities. Accordingly, to educate flexible thinkers, instructional environments must take into account the interplay between individual perceptions on knowledge and learning, and changes experienced during interdisciplinary problem-solving (Meyer et al., 2008).

For instance, some of the threshold concepts that comprise the subject matter of the field of Writing Studies (WS) are bounded by core concepts such as genre, purpose, audience, rhetorical situation, and situated practice. However, the interaction between writing and the domain knowledge of other disciplines (e.g., history, philosophy, engineering, and physics) suggests the existence of other threshold concepts relevant for interdisciplinary spaces/interactions between the field of Writing Studies and other disciplines/professions. Therefore, disciplinary professors including practitioners of WS should develop awareness of the ways of thinking and doing of the fields that are intertwined with writing. This awareness is an opportunity to correlate and differentiate disciplines across the curriculum.

This agenda might be useful to complicate assumptions about general education[22] as an interdisciplinary curriculum in which boundaries and threshold concepts disappear to riskily retain the students in a preliminal stage of understandings about relationships between

22 General Education is a distinctive feature of the U.S. Higher Education system that is not necessary present in other universities around the world. According to Adler-Kassner (2014), general education has been an effort within the U.S. academy to "create the dynamic tension between liberal learning, professional training, and Disciplinarity" (p. 438). In other higher education systems, core courses (many of them related to humanities,

writing and disciplines. This means that during this preliminal stage certain skills (e.g., argumentation, thesis, evidence, or writing process based on drafting, writing and editing) are seen as universal regardless the specific contexts and audiences (e.g., disciplinary genres, and disciplinary ways of thinking and doing with language and communication).

The problematic consequence of this view is that what is deemed as a universal skill is not important for instructors to teach explicitly, because it is not a threshold concept (Adler-Kassner, Majewski & Koshnick, 2012). When disciplinary professors including writing instructors acknowledge the existence of threshold concepts, explicit teaching practices are undertaken to support student learning. An awareness that Writing Studies has on threshold concepts may advance the disciplinary status of the field as well as define a "subject matter" for students to provide disciplinary language to talk and deal with writing in their disciplines.

However, this approach also complicates the delimitation of threshold concepts shared with other disciplines; therefore, the challenge is to describe developmental expectations of ways of doing and thinking in disciplines as an interdisciplinary domain between the field of Writing Studies and other disciplines by connecting their subject matters (knowledge domain) and language (writing, speaking, reading, and communication). The analysis of this chapter, therefore, contributes with this agenda.

2. Curriculum endeavors beyond first year composition

Freshman composition courses (FYC) are sometimes seen as the learning spaces to support college students with new writing situations. However, these curriculum initiatives are not meant to prepare college students to deal with all rhetorical demands they will

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social sciences, writing in mother tongue and second language, and statistics) might count as this U.S. educational goal of seeing core education as less disciplinary-oriented.

encounter in future writing situations especially workplace experiences. This is in part why curriculum endeavors are needed after freshman and also there is an ongoing debate about the scope of FYC. For instance, it has been proposed that FYC students should be taught about how to reflect on their own writing development by analyzing the process by guidelines, writing samples (positive and negative), and instructor feedback. Additionally, students must be exposed to learning experiences in genuine environments outside of classrooms (Carroll, 2002).

However, FYC instructors usually struggle when they are asked to prepare students to write for different activity systems[23]. Sometimes, they are asked to teach about disciplinary genres while also introducing students to college genres. Even if students were exposed to all disciplinary genres in a FYC class, there is no enough time in one course to gain genre knowledge of a discourse community (Wardle, 2009). Moreover, writing instructors cannot prepare students for every genre, nor they can foresee every assignment that students will be assigned (Wardle, 2007). Further, writing specialists/instructors will be always "the outsiders" of disciplines. Even if FYC instructors can become familiar with conventions of disciplinary genres, the activities of FYC do not provide the content needed to practice disciplinary writing in meaningful ways. These types of genres have been called “mutt genres”, that is, genres that mimic communicative practices of discourse communities outside classrooms; as a result, the risk is that the purposes and audiences of FYC courses tend to be vague and even contradictory (Wardle, 2009).

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23 “Activity systems” is a theoretical category useful to explain that cultural experiences are naturally linked to contradictions arising out from the division of labor (i.e., different participants who are pursuing one common goal and simultaneously seek personal motives while accessing hierarchically to stratified sources within a collective activity). These contradictions are the source of tensions and conflicts, since participants, especially those with less power in a hierarchy chain, struggle with creating connections between the common goal (social motives of the collective activity) and individual actions (personal motives) (Russell, 2010).

The latter explains in part the advocacy of curriculum endeavors across time by incorporating writing assignments of the discourse community that students belong to (e.g., project proposals and reports of designing projects for engineering students). However, this implies also deciding degrees of difficulty and variation of writing tasks across time and scaffolding for students accordingly (Beaufort, 2007).

One pedagogical approach to address variation advocates for carrying out the initiatives by integrating activity theory and genre theory. This implies that students should be exposed to conceptualizations of writing as a cultural tool embedded in activity systems. As a result, they gain awareness about diverse and ongoing social roles that writers can enact as genre users (consumers and producers) in large institutions/communities across time and contexts (Dias & Paré, 2000; Brent, 2011).

Additionally, teaching should incorporate genres of specific disciplinary communities that students must be engaged with, through actual intellectual pursuits of such communities (Beaufort, 2007); this is, students should learn by enculturation experiences. However, immersion in workplace activity systems or other non-schooling experiences is not sufficient; students must also be prepared to take advantage of circumstances (Brent, 2011). This means that scaffolding is also necessary in integrating new knowledge (i.e., recontextualizing prior knowledge in the context of the new) by making comparisons among prior and new writing situations through specific theoretical lenses about writing (Wardle, 2009), particularly, because students struggle in making sense of the goals of writing assignments they are assigned (Carroll, 2002; Beaufort, 2007).

Pedagogical initiatives focused on developing authorship and ownership advocate for writing curricula that articulate systems of activity from school-based writing and workplace writing. This approach reinforces the idea that one type of writing is not less valid than the other, teachers thus need to find pedagogic ways to bridge the world of school and the world of work (Dias et al., 1999).

Designing writing instruction and professional writing curriculum to bridge school and work worlds requires an extensive effort with other faculty members and not only writing faculty. Teaching professional writing could be led by the practitioners of the discourse community, but they are not necessarily aware of the role and conventions of writing in their professional practices. Therefore, faculty members should also gain awareness, by working with writing faculty, about their discourse community, professional genres, and rhetorical situations, which in turn will be later taught to the students (Beaufort, 2007).

Initiatives are not only advocating for bridging school and work worlds but also acknowledging the role of literacy environments other than writing courses. Studies have shown that students develop and draw on rhetorical knowledge to face new writing situations as a result of the influence of variety of writing experiences. Therefore, an ideal rhetorical education should offer multiple literacy environments to favor writing growth; for instance, course sequences and other literacy opportunities outside classrooms designed according to disciplinary expectations of growth within programs/majors/fields (Carroll, 2002; Beaufort, 2007; Brent, 2012).

By acknowledging that rhetorical knowledge of the students draws on repurposing knowledge from diverse literacy experiences, some university writing programs (first-year writing programs, writing across the curriculum programs, writing intensive courses, and specific advanced courses for majors) are advocating for "teaching for transfer." This pedagogical approach promotes knowledge transfer by preparing students to analyze new writing situations according to rhetorical concepts learned by writing instruction (e.g., genre, purpose, and audience). This way of thinking about writing fosters development of metacognitive awareness, favors knowledge transfer, and prepares students to utilize adequately rhetorical awareness in writing performance (Moore, forthcoming).

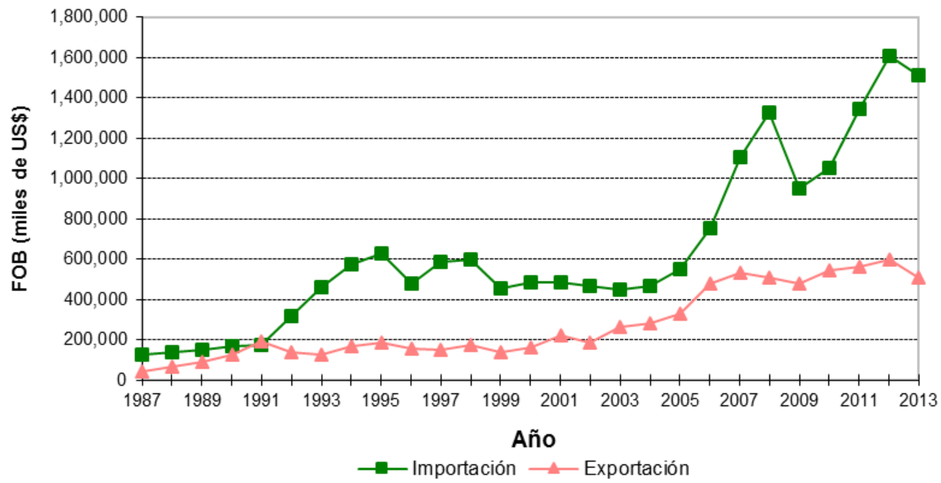
This model called “writing about writing”, instead of “learning about writing” embraces as a subject matter, for instance, how people use writing, how people learn to write, how systems of genres mediate the achievement of workplace goals, how "discourse communities" impact on language use, and reasons of the disciplinary writing variation (Wardle, 2009). This approach also favors knowledge integration by supporting students in developing a theory of writing (threshold concepts in writing), which provides lenses and strategies to analyze and reflect about new writing situations (Beaufort, 1999; Brent, 2011).

This second section of the literature review reveals the advocacy for writing instruction by incorporating learning experiences from contexts other than classrooms. One pedagogical debate emerging from this overview is over defining the “subject matter” of writing courses, especially defining disciplinary/professional writing expectations as ways of doing and thinking that might count as threshold concepts of disciplinary/professional writing. Leading such pedagogical initiatives demands an interdisciplinary work among writing instructors, other disciplinary professors, practitioners of the fields, and other stakeholders who are involved in communicative and writing practices of the professions. Accordingly, this chapter contributes in part to this agenda by exploring expectations of verbal and non-verbal writing (e.g., graphics, tables, or pics) and communication over time in an engineering subfield.

C. *General features of the regional and institutional contexts of data collection*[24]

The Industrial engineering major selected as a research site is located in a mid-size city in the southwest of Colombia. According to the official information available in the website of the Town Hall, the employment rate in the City was 55% in 2011 while exports represented 500,000 dollars and imports 1,000,000 dollars in 2010 (figure 1).

Figure 1
Exports and imports by local custom 1983-2013



Source
"Www.cali.gov.co." *Cali En Cifras*. Web. 5 July 2015.
<http://www.cali.gov.co/publicaciones/cali_en_cifras_planeacion_pub>

The economic activities in the region are: sales business (21%), banks (21%), estate agency services (16%), technical and repair services, communication, education, health, and beauty services (13%), industry (11%), transportation services (9%), agriculture (5%), and building trade (4%).

The university in which the major is offered is a private university whose mission embraces an international vision through integrating university goals in teaching, researching, and outreach programs for educating creative and leading individuals based on an humanistic

24 The information presented in this section was consulted during March 2014 through the websites of the Town

approach for generating knowledge and solving problems regionally, nationwide, and internationally. This institution was established in 1970 (45 years of existence). The student population is about 8,450 students. Freshman student demographics in 2013 were 54.9% women and 45, 6% men between 15-18 years old; 55% of the student population were middle class, 30% low income students, and 13% high income students[25].

This university is comprised of 651 faculty (233 tenured professors and 418 adjunct professors), and 562 administrative staff. Institutional research has been strengthened as one of the main university goals. Currently, the institution has 28 research teams recognized by the National Department of Science, Technology, and innovation (Colciencias). Moreover, the institution has endowed 72 laboratories. In 2015, the first international patent has been granted to the University[26]. The Institution is comprised of 4 faculties: Engineering, Sciences, Economics and Business, and Communication; 21 undergraduate programs; 11 specialization programs (specialization is a graduate level in the Colombia shorter than a master program), 7 master programs, and 6 technological programs (tertiary levels as college levels in the U.S.).

The Program in Industrial Engineering was founded in 1971 (44 years in existence); although, as an undergraduate program, the major dates since 1958 in Colombia. The graduating students belonged initially to the industrial sector but became progressively part of the services companies. This field aims at improving internal processes in companies to increase profits and strengthen business efficiency to compete in local and global markets.

Hall, the University, and the Colombian Ministry of Education.

25 UAO en cifras. (n.d.). Retrieved September 17, 2015, from http://www.uao.edu.co/la-universidad/planeacion-y-desarrollo-institucional

26 The name of the patent is "Ceramic Biocomposite for Bone Regeneration" and was a project led by Professor Sandra Arce Guerrero of Mechanical Engineering. Information taken from: "international patent for biocomposite bone regeneration." International Patent For biocomposite bone regeneration. Web. 13 Aug. 2015. <http://www.uao.edu.co/noticias/patente-internacional-para-biocompuesto-de-regeneracion-osea>.

Such improvements must comply simultaneously with national and regional policies and standards regarding labor health and security for working environments. In doing so, practitioners must be prepared to diagnose current and further problems in order to propose improvement projects accordingly; thus, industrial engineers are deemed as proactive professionals for leading institutional transformations.

The curriculum is arranged in 10 semesters (16 weeks each) for daytime and night students. Undergraduate students of this program can be enrolled in daytime classes and after the fifth semester can switch to the night program. The night program was the only undergraduate program in the city in 1961, mostly because at that time the institution sought to offer education for non-traditional students, who were workers available to study after 6:00 pm. According to the educational project of the program, in July 1983, after getting the approval from The Colombian Institute for the Promotion of Higher Education - ICFES, the program was offered in daytime. Consequently, the academic and administrative infrastructure of the University was improved (e.g., the library extended opening hours and increased number of titles; the laboratories were available from morning hours; more tenure-track professors were hired, and curriculum reforms were approved by the Governing Board to allow enrollments in day and night courses simultaneously)[27].

Current students complete the degree with 174 credits/units distributed as follow: 88 credits for core education, which includes 58 credits for courses on mathematics, physics, and chemistry, and 30 credits for courses on ethics, political science, five English courses, and a freshman composition course in Spanish; the courses for core education are only offered for engineering majors except for English courses. The remaining 86 credits include 68 credits for professional specialization, and 18 credits for elective professional. Since 2011, Industrial Engineering students must enroll in the eighth semester a senior thesis research seminar led by disciplinary professors aiming at supporting on writing their proposals; during the 10th semester they must enroll a research thesis course to be advised by a supervisor (which could be seen as an independent study in the U.S. Higher Education system) (figure 2).

Figure 2
Current curriculum of the major in Industrial Engineering

Color conventions
Basic science
Basic science in engineering
Applied Engineering
Complementary Education

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8	Semester 9	Semester 10
Basic Math	Calculus I	Calculus II	Differential equations	Study of work	Production system and inventory	Planning and control			
	Lineal Algebra	Physics I	Physics II	Physics III		Statistical process control			Advanced management of production
	Algorithms and programming	Statistics I	Statistics II	Operations research I	Operations research II	Logistics	Technological management	Engineering of companies	
Introduction to Engineering I	Introduction to engineering II	Conceptual Design	Systemic thinking		Processes and Materials	Industrial Processes	Security Management and Health in workplaces	Simulation	Online professional elective course
Foundations of Industrial Engineering				Chemistry	Basic elective course	Environment and sustainable development	Knowledge management and human resources	Plant design	Seminar in Industrial Engineering
Oral and written communication				Business Economy	Costing System	Economic and Financial Engineering	Project Management	Free elective course	Senior Thesis
Personal development			Additional activity		Ethics		Financial Economy	Professional elective course I	Professional elective course II
English I	English II	English III	English IV	English V			Colombian Political Constitution	Elective course in Humanities	

Source
"Plan De Estudios/Ingeniería Industrial." Universidad Autónoma De Occidente. Web. 13 Aug. 2015. <http://ingenieria.uao.edu.co/boletin/galeria_imagenes_boletin/planes2013/industrial.html>.

According to the institutional policy regarding senior theses, students are allowed to pursue the following types of projects: a) research projects; b) internships in research teams,

27 "PROYECTO EDUCATIVO DEL PROGRAMA DE INGENIERÍA INDUSTRIAL." *Universidad Autónoma De Occidente*. Web. 18 Sept. 2015. <http://www.uao.edu.co/sites/default/files/PEP_ING_INDUSTRIAL_2011.pdf>

companies or non-profit organizations; c) business creation; and, d) scientific, technical or artistic innovations. Furthermore, students are allowed to skip the senior thesis requirement, if they have achieved a GPA of 3.5/5.0, which lets them to enroll in a graduate course in the same institution as an approval for the requirement. It is not mandatory to complete the graduate program which the course belongs to.

This program was accredited by the Colombian Ministry of Education in 2008 for 4 years and in 2013 the accreditation was renewed for 6 years. In Colombia, the accreditation process is led by the National Council of Accreditation of the Ministry of Education. This accountability process of higher education dates since 1998 as a voluntary process that is coordinated and ruled by the Government; there are three types of national accreditations for 1) undergraduate programs, 2) graduate programs, or, 3) entire institutions that voluntarily decide to apply for this process.

International accreditation has been conducted as pilot experiences since 2009; for undergraduate programs in the fields of Medicine and Agriculture in two of the most outstanding public universities, and for doctorate programs in hard sciences (Physics, Biology, Mathematics, Chemistry, and Biomedical Sciences). This context suggests that for undergraduate programs in engineering, there is no international accreditation agendas currently developed and advocated by the Colombian government.

D. Disciplinary expectations on writing and communication in a Colombian major in Industrial engineering

Since this chapter offers insights that might inform writing curriculum design in a specific engineering subfield by including expectations of verbal and non-verbal writing (e.g., graphics, tables, or pics) and communication over time, two types of data are described in this section:

a) Faculty members' expectations regarding conducting and writing a senior thesis, since this is the most ambitious writing project students need to address in this undergraduate curriculum; and,

b) Disciplinary learning expectations of ways of doing and thinking with special attention to writing and communication including non-verbal expectations (e.g., graphics, tables, or pics) that are stated by the instructors through syllabi (by semesters and by curriculum years, namely, freshman, sophomore, junior, and senior).

1. Faculty members' expectations regarding conducting and writing a senior thesis

Two semi-structured interviews were conducted and audio-recorded in Spanish by Skype with faculty members affiliated to a Colombian university who accepted to participate voluntarily: The Director of the Program, and the Coordinator of the senior thesis. The analytical assumption was that knowledge and experience of these two participants could provide expectations more aligned at the level of the Program rather than as a personal perspective[28]. Consequently, the data was created from a purposeful sample comprised by participants who held special experience and competence in the issue as well as were willing to participate (Merriam, 2009).

The survey protocol was comprised by 12 questions. The first four questions aimed at exploring the features of the field, Industrial Engineering, through asking the participants about: 1) their academic and professional trajectories; 2) their opinions about the importance of the Industrial Engineer locally (for the region and the country) and internationally; 3) the role of writing in the field; and, 4) to what extent writing a senior thesis is similar to the types of professional writing they had mentioned[29]. The following six questions aimed at exploring the institutional conditions in which the senior theses are conducted and written by students in the Program; the interviewer asked about the general challenges and the specific writing challenges that students face in conducting the four types of senior theses (research projects; internships in companies, research groups, or non-profit organizations; business initiatives; and, scientific, technical or artistic innovation). Finally, two questions on problematic and successful senior thesis stories were included.

The two participants shared the following learning expectations associated with conducting and writing a senior thesis: 1) senior theses open job opportunities for students; 2) senior theses should include how to make decisions to improve companies' processes and practices; 3) senior theses should be documents clearly written by following the format expected, and integrating linguistic and non-linguistic resources to convey a bounded problem and a professional solution accordingly; and, 4) senior theses might expand final papers of prior courses and also imply repurposing writing knowledge from a research seminar[30].

28 The two participants are tenured professors and hold about two uninterrupted decades working as university teachers and completed their master degrees; one in Industrial Engineering and the other in Administration and Business.

29 Making inferences about features of the field was necessary, since the methodological assumption of this study is that the expectations in writing a senior thesis are associated with repurposing and deploying disciplinary knowledge learned in the Program.

30 Since the original interviews were conducted in Spanish, the fragments utilized as illustrations of the analysis were translated into written English; however, the verbatim accounts do not mirror spoken English (Poland, 2002, p. 154). The following symbol will be used (…) to indicate eliminated lines not pertinent in illustrating the analysis.

1.1. Senior theses open job opportunities for students

The participants agreed that conducting a senior thesis is an opportunity to open job positions for students; particularly, in the case of senior theses that have been conducted as company internships. When asking regarding successful stories of conducting senior thesis, one of the interviewees mentioned: *"…this student [name of the student], his defense was last week and he told us that given his good performance in the company, he got an opportunity…he conducted a study…he did a study on salaries, and the company really liked his professional performance, so we got the opportunity that he was hired…".* Based on faculty member expectations, it seems that students´ performances as practitioners during the internships and especially as writers of the senior thesis are kairotic[31] professional moments for them.

1.2. Senior thesis should include how to make decisions to improve companies´ processes and practices

Regarding the relationship between conducting a senior thesis and deploying disciplinary knowledge, the participants agreed that students should be able to draw on methods of the field to diagnose company problems and propose solutions accordingly. When talking about "a good analysis" in conducting a senior thesis, one of the participants remarked: "*Well, we are focused on assessing how students address a problem and its solutions, because the most important issue is how you solve the problem; so, for instance, students say "low productivity", well, ok. What is your proposal to increase the productivity in this company?" ah, well, "I conducted a study about methods and time, I defined the indicators to measure this, I proposed how to modify this machine in the company or change* *these staff, and this is my result". Then, this is what we have seen and actually if the enterprises allow them doing this, because there are other projects that remain only as proposals."*

The ultimate goal of making decisions in this field is to improve processes and practices in companies. In analyzing and bounding the problems of senior thesis projects, faculty members are expecting students to be able to conduct measurement procedures and differentiate these activities from project objectives. For instance, one of the participants provided this type of example: "*well, an example, when a student tells me "Diagnosing a process of a specific area in the company" and that is it! The student envisions only the diagnosis and never include what and why is gonna be the scope of the process, sometimes when they are defining the objectives, students confuse objectives with activities; so, for instance, they write "draw diagrams", "identify processes"…"measure times" and they define 6 objectives, 7 objectives that are not objectives, rather, activities…so, let´s say this is the main problem that we have seen in the objectives section of the proposals..."*

Particularly, students should differentiate while writing the proposals between conducting the procedures of the field (activities) in contrast to the reasons (objectives) that justify conducting such activities. This is one of the explanations offered by the participants: "*When the students turned in the first objectives, well, the title should be coherent with the general objective, then, they titled the project as "Implementing a prevention plan on high-fall risks addressing small building-trade companies of [name of the city] according to the Law 1409-2013 of protection regulations from high falls". This was the second proposal. As specific objectives, they wrote about measuring something that is immeasurable, and then*

31 Kairotic moments emerge when rhetor's ability allows her to select and/or create an opportune moment to act proportionally (Artemeva, 2009).

"evaluating the equipment conditions ", which is unmeasurable also, and "designing a prevention plan on risks addressing the small companies", which might be more accurate than the prior two, mostly because we are talking about small companies, these types of companies will not allow us to measure."

Accordingly, it seems that the interviewees are expecting that students convey through writing such differences across contents and wording throughout the sections of the proposals (i.e., title, objectives, and methodology of the projects).

1.3. Senior theses should be documents clearly written by following the format expected, and integrating linguistic and non-linguistic resources to convey a bounded problem and a professional solution accordingly

The most salient expectation between these two participants is that students should differentiate among the sections that comprise the proposals (i.e., title, general and specific objectives, literature review, justification, problem statement, and methodology). This might be one of the most challenging issues to be accomplished by the students. One of the interviewees commented: *"the most complicated issue is everything, the work they present from title, objectives, they do not know what is a literature review, what is a justification, they do not know how to state a research problem…these issues have been improving, because the Program since two or three years ago has also offered a course named research seminar, so there the students are supported to improve such competencies, but the improvements have impacted on problem statements; however they still have problems in defining general and specific objectives, which is technically the project…from there, everything is interrelated."*

Additionally, writing cohesively within and between the sections is also expected. Particularly, the participants mentioned the importance of writing paragraphs coherently; for instance: "*… in final reports, eh, the structure should be improved, students need to follow a thread in their projects, I mean, what is a chapter, what should be included in this chapter, how to connect, how to claim that the objectives were accomplished, there are students that do not even use nomenclature for the data and one says: ok, this info where comes from? Isolated paragraphs without connections and one says: well, I can understand what is the idea here, but this info cannot connect with that; then, it is very difficult to convey the results through writing.*"

Furthermore, it is also expected that students can integrate linguistic and non-linguistic material by presenting and analyzing information in their projects. Graphics and tables are seen as resources to summarize information deployed by prose. When talking about specific cases that the participants recalled, this interviewee mentioned: "*Well, I got the case; well; now I got a case of a student who I advised about strategic planning. She conducted initially an internal and external analysis, which was an endless report of pages, pages, pages, pages. I told her: "If this report is read by an industrial engineer, he will undermine your work. All this should be depicted by tables. So, take the relevant aspects, write with adequate punctuation, but show me all this as a depiction by figures and tables that allow a better visualization of what you have done so far.*"

However, written interpretations are also part of the expectations to aggregate meaning to what has been deployed by non-linguistics recourses. This is what one of the interviewees pointed out when talking about striking aspects of evaluating senior thesis reports: *"well, let´s say that writing is difficult for us, so we have to correct students' documents several times and even there are students that only turn in tables, tables, tables,* *but there are no interpretations, descriptions, definitions, they do not define what they have there, why these tables are there, so we have to give them back the documents and tell them: "the work is not only comprised by tables, you have to write, you have to convey what you wanted to mean with all this you have here, ok?, in this document?"*

Finally, the participants agreed that learning how to write paragraphs cohesively, and particularly, how to write the proposals should be learned in the research seminar enrolled by the students in the 8th semester. For instance, one of the faculty members said: "*Actually, this semester we were analyzing with [name of another instructor], well, what is happening with the research seminar in the Program? Students are enrolling the seminar? Well, this is a course we have in the semester eight, between eighth and ninth…they actually should enroll it as a requirement before starting senior thesis, and the idea is that students can start to formulate a preliminary proposal and be able to write adequately and meaningfully by connecting paragraphs…"*

1.4. Senior theses might expand final papers of prior courses and also imply repurposing writing knowledge from a research seminar

The participants acknowledged that conducting a senior thesis is an opportunity to repurpose and integrate what students have learned during the Program. In fact, one of the participants talked about this when explaining what might count as "good analysis" in a senior thesis: *"mmm, [a good analysis does not depend on] analytical models, rather, the learning contents of the courses they have previously enrolled, let's say, in the course "methods and time", they learned all the tools of methods and time; if they have learned Statistics, they should know that if they got normal distribution, then they will run variances; if they are working on quality control, then they should conduct the projects with the tools* *accordingly. So, every course allows learning those tools and a student should decide what to apply in the project."*

Consequently, it is expected that final projects from prior courses can be expanded in terms of the scope to accomplish a senior thesis. For instance, this faculty member explained how the scope of prior projects conducted in disciplinary classes could be expanded: "*for instance, in my course: Engineering of Methods, I assign a project in which they analyze a product production, from diagnosis, depiction (...), time, all this process, so, when the student is starting senior thesis, I tell them, " you could expand this project, but you should analyze more than a product production, instead, a process production of five lines of product production, for instance, of the same company, well, it depends on the size of the company...because, if we talk of [name of a large and leading company in the region], it would be impossible to conduct such type of project; so, let's say, this is the scope, by bounding of the project."*

Furthermore, it is expected that students be able to repurpose knowledge from a research seminar enrolled between 7th and 8th semesters to write paragraphs cohesively and present proposals by differentiating its sections (e.g., literature review, justification, and problem statement).

1.5. Summary

This analysis suggests that the participants regard conducting a senior thesis as a job opportunity for students. This expectation is better understood within the context of the regional economy; due to the low employment rate of the city, deploying a successful professional performance while conducting a senior thesis might improve opportunities for students to get work positions. This professional performance of students that is expected and conveyed through senior thesis proposals and reports is mainly associated with being able to make decisions to lead and propose institutional changes in companies to improve processes and profits of organizations. In terms of deploying disciplinary knowledge through writing a senior thesis, the expectation is that students integrate linguistic and non-linguistic resources to convey their professional performance. To accomplish these expectations, faculty members are assuming that students are repurposing knowledge from a mandatory research seminar enrolled as a requirement before starting the advising process and expanding the scope of final papers written in prior professional courses.

The next portion presents the analysis of syllabi as methodological windows for exploring ways of doing and thinking that can be taught and must be learned over time in order to become enculturated into a discipline/profession, with special attention to expectations of verbal and non-verbal writing and communication.

2. Disciplinary learning expectations stated through syllabi

To better understand how the disciplinary learning expectations of ways of doing and thinking and writing are intertwined in the major of industrial engineering from which the prior faculty members interviewed are affiliated with, a qualitative survey was applied to explore writing experiences from students' perspectives (appendix 1). This portion of the analysis is based on 18 syllabi of classes of this major that were mentioned by the undergraduates in the survey as courses in which they had had positive writing experiences (table 1).

Table 1
Classes mentioned by the students in a survey and organized by semesters[32]

Semester	Name of the class in Spanish	Name of the class in English
1	Expresión oral y escrita	Oral and written communication
Between 1 - 4	Democracia y Constitución Política	Democracy and Colombian Constitution
1	Introducción a la ingeniería 1	Introduction to engineering 1
2	Introducción a la ingeniería 2	Introduction to engineering 2
2	Física 1	Physics 1
3	Física 2	Physics 2
3	Diseño básico de ingeniería	Basic design in engineering
4	Ética	Ethics
4	Pensamiento sistémico	Systems thinking
5	Física 3	Physics 3
After 5th semester	Ingeniería de métodos	Method Engineering
After 5th semester	Logística integral	Integral logistics
After 6th semester	Diseño de planta	Plant design
7	Gestión y control de calidad	Management and quality control
7- 8	Finanzas y presupuestos	Finance and budgets
7-8	Seminario de investigación	Research seminar
8	Gerencia de proyectos	Project management
9	Gestión tecnológica	Technology Management

The students mentioned in the survey they had positive writing experiences from different classes from freshman to senior years. There was no an overt pattern among the amount of mentions of the classes by semester (see distribution of the occurrences of the classes mentioned in appendix 2)[33].

The following analysis was conducted under the assumption that the pedagogical approach on threshold concepts suggests that it is useful to explore:

- ways of doing: methodologies to become a practitioner or learn a discipline; and,
- ways of thinking: systems of values/ideologies of a discipline/profession including types of reasoning for conducting cognitive procedures such as comparing, criticizing, making claims, and drawing conclusions to learn a discipline or become a practitioner.

32 This engineering program is completed in 10 semesters 17-week each.

These ways of doing and thinking can be taught and must be learned over time in order to become enculturated into a discipline/profession. Therefore, this analysis was regarded as a methodological window to identify features of disciplinary/professional learning over time to become a practitioner in the major and the intertwining, if any, with writing and communication.

2.1. Textual features of the sample and data analysis

The format/template of the syllabi of the sample is standardized within the institution; therefore, every syllabus is arranged into the following categories:

Subtitles of the sections in Spanish	Subtitles of the sections in English
Logo de la universidad	University logo
Misión institucional	Institutional mission
Nombre de la asignatura	Course title
• Identificación: • nombre del curso • departamento que lo ofrece • carácter de la asignatura: obligatoria, validable homologable y si requiere prerrequisitos • código de la asignatura • número de créditos • programas a los que se ofrece	• Identification: • course name • department • nature of the subject: mandatory, homologous (if taken in another institution), validated (if taken in the same university but in another major), and if prerequisites are required • Course code • number of credits • major
Área de formación de la asignatura: básica, profesional, profundización	Area of training: basic , professional , emphasis, operations and logistics
Componente al que pertenece la asignatura: humanístico	Component of training: humanistic, projects and design, emphasis, physics, operations, introduction
Objetivos: generales y específicos	Objectives: general and specific
Organización de contenidos organizados en 17 semanas	Contents scheduled for 17 weeks (one semester)
Metodología	Methodology
Actividades, ejercicios claves y recursos	Activities, key exercises, and resources
Evaluación	Assessment
Bibliografía	Bibliography

33 21 classes were mentioned by the students in the survey, but only 18 were classes of the major in industrial

Five types of analyses were conducted while grounded categories were created:

1. Identifying ways of doing (methodologies to become a practitioner or learn a discipline) and ways of thinking (system of values/ ideologies) that were deployed throughout the sections of the syllabi. Examples of these grounded categories are in appendix 3.
2. Identifying specific ways of doing and thinking related to writing or other communication abilities according to the list of ways of doing identified in the analysis 1. Examples of these grounded categories are in appendix 4.
3. Identifying presence of writing (verbal and non-verbal) in learning and assessing contents as part of the pedagogical and evaluation strategies in the classes that are described in the following sections of the syllabi: a) Contents that are scheduled for 17 weeks (one semester); b) Methodology; c) Activities, key exercises, and resources; and, d) assessment. Examples of these grounded categories are in appendix 5.
4. Identifying writing expectations (verbal and non-verbal) for assignments that are overtly stated in the following sections of the syllabi: a) Activities, key exercises, and resources; and, b) assessment. Examples of these grounded categories are in appendix 6.
5. Identifying ways of doing and thinking related to visual communication that are deployed through all of the sections of the syllabi. Examples of these grounded categories are in appendix 7.

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engineering that is the research site of this study.

2.2. Results[34]

2.2.1. Ways of doing and thinking

The most frequent ways of doing and thinking that count as learning expectations in the sample were: a) Making claims to analyze case studies based on theoretical frameworks of the class (10 occurrences); b) Making decisions to design solutions based on procedures learned in the class (7 occurrences); and, c) Making decisions to design and redesign to improve productivity and profitability (7 occurrences). The list of the total ways of doing and thinking identified across the syllabi and its occurrences across the sample is in table 2:

Table 2
Ways of doing and thinking identified across the syllabi

Ways of doing (methodologies to become a practitioner or learn a discipline) and ways of thinking (system of values/ ideologies)	Occurrences
• Making claims to analyze case studies based on theoretical frameworks of the class (CSTF)	10
• Making decisions to design solutions based on procedures learned in the class (MDDS)	7
• Making decisions to design and redesign to improve productivity and profitability (MDPP)	7
• Writing implies prior reading and intertextuality (WPRI)	4
• Reading carefully bibliographic resources (RCBR)	4
• Making measurements and creating data (CD)	4
• Solving problems methodically (SPM)	4
• Multivariable thinking to make decisions (MVT)	3
• Addressing writing as a process (WP)	3
• Working collaboratively (WC)	3
• Bounding and defining engineering problems (EP)	3
• Selecting materials and procedures efficiently based on budgets (MPB)	3
• Developing and implementing control and management strategies (CMS)	2
• Preparing and delivering oral and written presentations (PDOWP)	2
• Mastering an engineering protocol for projects (MEP)	2
• Selecting bibliography (SB)	2
• Writing cohesively (WCY)	2
• Evaluating others' written productions (EOWP)	1
• Including graphics in presentations (GP)	1
• Making decisions to design and redesign on human resources expectations of companies (MDHR)	1
• Information management (IM)	1

34 In this section some cases are used to illustrate the analysis. Since the original data was collected in Spanish, the cases were translated into English. These translations were done by *Ingrid Julieth Hernández Cuero*, senior student of the Degree in Foreign Languages of the *Universidad del Valle* in Colombia.

• Identifying differences between Engineering as a field and the student major (ESM)	1
• Standardizing procedures (SP)	1
• Writing Standards and guidelines manuals (WSM)	1
• Raising resources and funding (RRF)	1
• Anticipating social, environmental, economic, and legal limitations of a project to propose mitigations (LM)	1
• Depicting graphically and holistically companies (DGHC)	1
• Multivariable thinking to make decisions (MVT)	1
• Developing systemic thought (ST)	1
• Writing a senior thesis proposal (WSTP)	1
• Mastering a standard citation format [ICONTEC] (SFC)	1
• Mastering genre conventions of a senior thesis for the institutions (STI)	1
• Understanding the interplay between conventions, mechanics and intended audiences (CMA)	1
• Writing as senior thesis as a process bounded by timelines, deadlines and budgets (WPTDB)	1
• Expressing a personal voice respectfully among others vantage points (PVAO)	1

The number of mentions of the ways of doing identified in the sample suggests overall that learning relies on conducting case studies to apply theoretical frameworks of the classes. Furthermore, the students should learn how to solve problems primarily by thinking under principles of productivity and profitability for companies.

The following is an example of “ways of doing and thinking” to learn the discipline: Making claims to analyze case studies based on theoretical frameworks of the class (CSTF), which emerged in the evaluation section of a syllabus for the class “Plant design” enrolled in 6th semester (fragment underlined):

Example 1
Ways of doing and thinking emerging from the evaluation section of the syllabi

> ***6. Evaluation***
> - *<u>Implementation in the case of assigned enterprise</u>.*
> - *Workshops, possible risks in a given place according to the risk type.*
> - *Oral tests.*
> - *Written tests.*

Another example of "ways of doing and thinking" to become a practitioner in the field, Making decisions to design and redesign to improve productivity and profitability (MDPP), appeared in the general objective of the class "Method Engineering" enrolled in 5th semester:

Example 2
Ways of doing and thinking emerging from the general goal of the syllabi

> ***2.1. General Goal***
> *Explaining the concepts related to the techniques of Methods Study and Work Measurement, in order to design and <u>improve productive processes</u> in manufacture enterprises and in services enterprises that satisfy marketing needs. <u>This process improvement will increase productivity and competition of local and national organizations</u>.*

The distribution of amounts of mentions of these learning expectations (i.e., ways of doing and thinking) across semesters depicted in figure 1 shows that the maximum amount of mentions of learning expectations identified in a syllabus was 14 for "Introduction to engineering 2" enrolled in semester 2, and the least amount of mentions of learning expectations was 1 for the classes "Democracy and Colombian Constitution" (enrolled between semesters 1-4), "Basic Design in engineering" (semester 3), and "Ethics" (semester 4).

Figure 1
Amount and distribution of mentions of ways of doing and thinking

The distribution of the amount of mentions of these learning expectations by classes and across semesters might suggest that in this engineering program there are two learning moments in which mentions of learning expectations are high in comparison with other semesters: in the freshman year (i.e., between 7 and 14 types of specific ways of doing and thinking were inferred from the syllabus of the classes "Introduction to engineering 1 and 2"), and also again towards the end of the program in the senior year (i.e., up to 11 mentions of ways of doing and thinking were identified from the syllabus of the class "research seminar" in semester 7-8).

2.2.2. Ways of doing and thinking related to writing or other communication abilities

Table 3 shows that out of 83 mentions of ways of doing and thinking identified across the syllabi, 39 were mentions related to writing or other forms of communication (i.e., 47% of the mentions are ways of doing and thinking related to writing or other forms of communication). For instance, "Expressing a personal voice respectfully among others vantage points (PVAO)" emerged from the FYC class in the following fragment of the content organization section:

Example 3
Writing and other communication abilities mentioned as a subject matter of the class

> ***4. Content Organization***
>
> *Thematic axis 3: Stance taking regarding statements and polemic situations. This implies that the reader, who approaches multiple visions, identifies different positions about a phenomenon. These positions are intertwined by cultural, social, political and historical perspectives and placed here and now.*
> *Furthermore, <u>there is a writer portraying his own world perspective through words. To accomplish this, the author has to consider contextual, sociocultural, discursive, grammatical, and lexical aspects</u>.*
> *It is convenient to say that this axis is focused on writing commentaries and essays. These texts are justified as long as <u>the author-reader voice is strengthened toward a situation or perception of the world, in which a critical, participative, and respectful position is necessary among others' different opinions</u>.*

Another illustration of ways of doing and thinking related to writing and communication, preparing and delivering oral and written presentations (PDOWP), appeared in the methodology section of the class "Project Management" enrolled in 8th semester:

Example 4
Writing and other communication abilities mentioned as a class methodology

> ***4. Methodology***
> *The course will be developed in three thematic units with different participatory methodologies including lectures, active participation of students through experiential exercises, videos, round tables, workshops, research projects, oral presentations, reading reports, and cases studies in actual organizations, besides student-teacher conferences.*[35]

Table 3
Occurrences of ways of doing and thinking in general and related to writing and other forms of communication

Ways of doing and ways of thinking related to writing or other forms of communication	Occurrences of mentions in total	Occurrences of mentions of ways of doing and thinking related to writing or other forms of communication
• Making claims to analyze case studies based on theoretical frameworks of the class (CSTF)	10	10
• Making decisions to design solutions based on procedures learned in the class (MDDS)	7	
• Making decisions to design and redesign to improve productivity and profitability (MDPP)	7	
• Writing implies prior reading and intertextuality (WPRI)	4	4
• Reading carefully bibliographic resources (RCBR)	4	4
• Making measurements and creating data (CD)	4	
• Solving problems methodically (SPM)	4	
• Multivariable thinking to make decisions (MVT)	3	
• Addressing writing as a process (WP)	3	3
• Working collaboratively (WC)	3	
• Bounding and defining engineering problems (EP)	3	
• Selecting materials and procedures efficiently based on budgets (MPB)	3	

35 Other examples of these types of learning expectations related to writing and other forms of communications are described in appendix 12.

• Developing and implementing control and management strategies (CMS)	2	
• Preparing and delivering oral and written presentations (PDOWP)	2	2
• Mastering an engineering protocol for projects (MEP)	2	2
• Selecting bibliography (SB)	2	2
• Writing cohesively (WCY)	2	2
• Evaluating others' written productions (EOWP)	1	1
• Including graphics in presentations (GP)	1	1
• Making decisions to design and redesign on human resources expectations of companies (MDHR)	1	
• Information management (IM)	1	
• Identifying differences between Engineering as a field and the student major (ESM)	1	
• Standardizing procedures (SP)	1	
• Writing Standards and guidelines manuals (WSM)	1	1
• Raising resources and funding (RRF)	1	
• Anticipating social, environmental, economic, and legal limitations of a project to propose mitigations (LM)	1	
• Depicting graphically and holistically companies (DGHC)	1	1
• Multivariable thinking to make decisions (MVT)	1	
• Developing systemic thought (ST)	1	
• Writing a senior thesis proposal (WSTP)	1	1
• Mastering a standard citation format [ICONTEC] (SFC)	1	1
• Mastering genre conventions of a senior thesis for the institutions (STI)	1	1
• Understanding the interplay between conventions, mechanics and intended audiences (CMA)	1	1
• Writing as senior thesis as a process bounded by timelines, deadlines and budgets (WPTDB)	1	1
• Expressing a personal voice respectfully among others vantage points (PVAO)	1	1
	83	39

The analysis reveals mentions of ways of doing and thinking related to writing and communication highly present at the beginning of the program (1-2 semesters) and at the end (7-9 semester) (see green boxes in figure 2) when comparing the amount of mentions across semesters.

Figure 2
Depiction in green of mentions of ways of doing and thinking related to writing and other forms of communication and in blue ways of doing and thinking not related to writing or communication

This analysis also reveals that during the first year students are exposed to ways of doing and thinking that configure two conflicting systems of values related to writing. In the FYC class, students are expected to "express a personal voice respectfully among others vantage points (PVAO)", whereas, in Introduction to Engineering 1, they should learn how to "write standards and guidelines manuals (WSM)".

The overall analysis suggests that the presence of ways of doing and thinking related to writing and other forms of communication are neither constant nor progressive over time; although, the students should utilize writing and other forms of communication as seniors, especially when are enrolled in a research seminar between 7th and 8th semesters; for instance, this is the type of ways of doing and thinking they are expected to fulfill in this specific class:

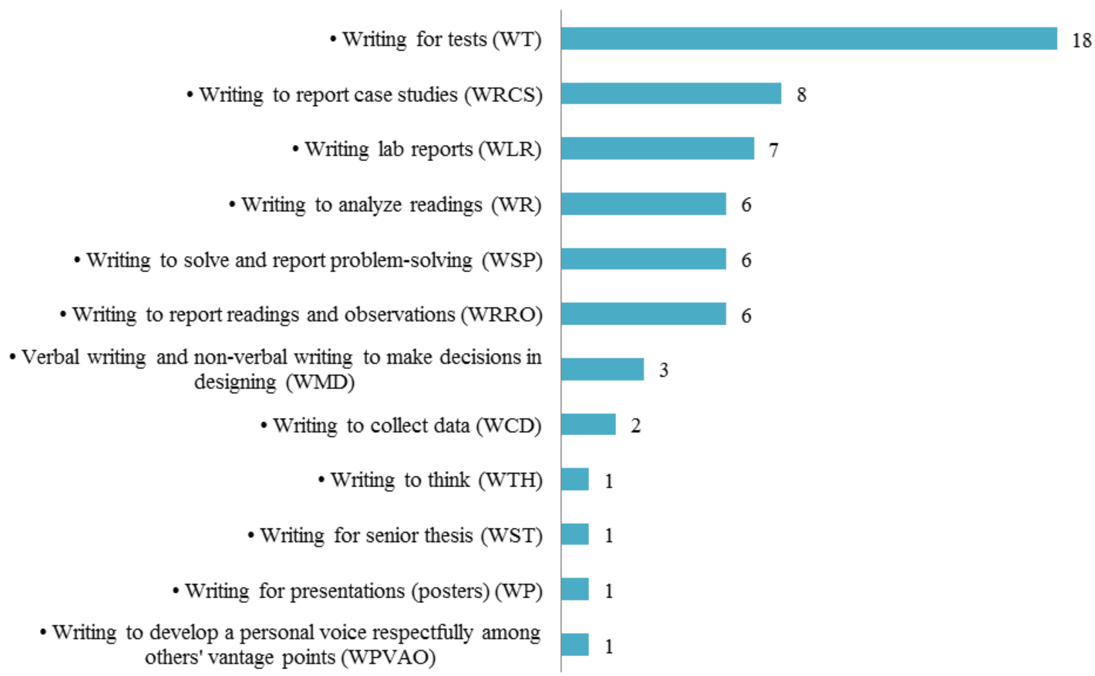
- Writing cohesively (WCY)
- Writing a senior thesis proposal (WSTP)
- Mastering a standard citation format [ICONTEC] (SFC)
- Addressing writing as a process (WP)
- Mastering genre conventions of a senior thesis for the institutions (STI)
- Selecting bibliography (SB)
- Understanding the internship between convention, mechanics and intended audiences (CMA)
- Writing as senior thesis as a process bounded by timelines, deadlines and budgets (WPTDB)
- Writing implies prior reading and intertextuality (WPRI)
- Reading carefully bibliographic resources (RCBR)

2.2.3. Writing presence (verbal and non-verbal) in learning and assessing contents

Writing is primarily used for testing (18 occurrences) according to the analysis conducted in the following sections of the syllabi: i) Contents; ii) Methodology; iii) Activities, key exercises, and resources; and, iv) Assessment).

However, the analysis also shows that writing is also utilized to support learning and assessment through reports of cases studies (8 occurrences), laboratories (7 occurrences), observations (6 occurrences), problem solving (6 occurrences), and readings (6 occurrences) (figure 3).

Figure 3
Writing presence (verbal and non-verbal) in learning and assessing in the classes



This analysis unfolds that "report" is a label to name a frequent genre that is expected to be produced by the students, either for lab reports (7 occurrences) or cases studies (8 occurrences). For example, in the section of activities of the class "Basic design in engineering" enrolled in 3rd semester the following it is stated:

Example 5
Writing reports as learning and assessment activity

> ***5. Activities, Key Exercises, and Resources***
>
> *Activities*
> *Pedagogical activities to verify learning outcomes and competences are: tests, midterms, final exams, workshops, quiz, expositions, reports, laboratory practices and visits to enterprises.*

Another instance is the section of methodology of the class “Physics” in 2nd semester:

Example 6
Writing reports as class methodology

> ***4. Methodology***
>
> The teacher:
> He will introduce and develop the contents relying on actual cases by lecturing. Contents will be reinforced by conducting exercises and applications. He will guide the students for developing abilities in data collection, operation of lab equipment, and reporting.

The tendency of mentioning “reports” coincides with the most frequent mentions of way of doing and thinking in the sample: a) Making claims to analyze case studies based on theoretical frameworks of the class (10 cases); b) Making decisions to design solutions based on procedures learned in the class (7 cases); and, c) Making decisions to design and redesign to improve productivity and profitability (7 cases). In other words, it seems that these ways of doing and thinking are primarily performed by the students when they write "reports".

The analysis of the presence of learning and assessing activities related to verbal and non-verbal writing suggests that students are expected to make decisions based on articulating these two types of systems in the freshman, sophomore, and junior years. See in figure 4 boxes in nude color: Introduction to engineering 1 (semester 1), Basic design in engineering (semester 3), and Integral logistics (semester 5). This is the case of the class “Integral Logistics” enrolled after the 5th semester; in the section of content organization the syllabus is mentioned a specific type of diagram as one of the class contents:

Example 7
A type of diagram is mentioned as class content

3. Content Organization *Week 7* *Business visit* *Visit Report- <u>Diagram of the SCM (Supply chain management)</u>*

Across semesters, the rest of mentions categorized as “writing presence” (depicted by colors other than nude color) are associated with verbal writing (figure 4); this is:

- Writing to develop a personal voice respectfully among others' vantage points (WPVAO)
- Writing for presentations (posters) (WP)
- Writing for senior thesis (WST)
- Writing to think (WTH)
- Writing to collect data (WCD)
- Writing to report readings and observations (WRRO)
- Writing to solve and report problem-solving (WSP)
- Writing to analyze readings (WR)
- Writing lab reports (WLR)
- Writing to report case studies (WRCS)
- Writing for tests (WT)

Figure 4

Depiction of writing presence (verbal and non-verbal) in learning and assessing contents in the classes

Semester	Name of the class	Writing presence 1	Writing presence 2	Writing presence 3	Writing presence 4	Writing presence 4
1	Introduction to engineering 1	• Verbal writing and non-verbal writing to make decisions in designing (WMD)	• Writing for tests (WT)	• Writing lab reports (WLR)	• Writing to report case studies (WRCS)	
1	Oral and written communication	• Writing to analyze readings (WR)	• Writing for developing a personal voice respectfully among others' vantage points (WPVAO)			
2	Physics 1	• Writing for tests (WT)	• Writing lab reports (WLR)			
2	Introduction to engi	• Writing for tests (WT)	• Writing to analyze readings (WR)	• Writing to report case studies (WRCS)	• Writing lab reports (WLR)	
3	Basic design in engineering	• Verbal writing and non-verbal writing to make decisions in designing (WMD)	• Writing for tests (WT)	• Writing to solve and report problem-solving (WSP)	• Writing to report readings and observations (WRRO)	
3	Physics 2	• Writing for tests (WT)	• Writing lab reports (WLR)			
4	Systems thinking	Writing for tests (WT)				
4	Ethics	• Writing to report case studies (WRCS)	• Writing for tests (WT)	• Writing to report readings and observations (WRRO)		
4-Jan	Democracy and Colombian Constitution	• Writing to report case studies (WRCS)	• Writing to report readings and observations (WRRO)	• Writing to collect data (WCD)		
5	Physics 3	• Writing for tests (WT)	• Writing lab reports (WLR)			
After semester 5th	Integral logistics	• Writing for tests (WT)	• Writing to report case studies (WRCS)	• Writing to report readings and observations (WRRO)	• Writing lab reports (WLR)	• Verbal writing and non-verbal writing to make decisions in designing (WMD)
After semester 5th	Method Engineering	• Writing for tests (WT)	• Writing lab reports (WLR)	• Writing to collect data (WCD)	• Writing to report case studies (WRCS)	
7	Management and quality control	• Writing for tests (WT)	• Writing to solve and report problem-solving (WSP)	• Writing lab reports (WLR)		
After semester 6th	Plant design	• Writing for tests (WT)	• Writing to report readings and observations (WRRO)			
8-Jul	Finance and budgets	• Writing for tests (WT)	• Writing to solve and report problem-solving (WSP)			
8-Jul	Research seminar	• Writing for senior thesis (WST)	• Writing to analyze readings (WR)	• Writing to think (WTH)	• Writing lab reports (WLR)	
8	Project management	• Writing for tests (WT)	• Writing to solve and report problem-solving (WSP)	• Writing to report readings and observations (WRRO)	• Writing to report case studies (WRCS)	
9	Technology Management	• Writing for tests (WT)	• Writing to solve and report problem-solving (WSP)	• Writing to report case studies (WRCS)	• Writing to analyze readings (WR)	

2.2.4. Writing expectations for assignments

Table 4 presents the list of mentions related to writing expectations for assignments. The sample displays 10 types of writing expectations for assignments, and 25 occurrences in total from the sections analyzed (activities and assessment of the format/template of the syllabi).

Table 4
Amount of mentions and types of writing expectations for assignments

	Writing expectations for assignments	Occurrences
1.	**Pertinence (P)**	1
2.	**Personal voice and critical stance based on theoretical concepts of the class (PVCSBT)**	1
3.	**Argumentative strategies (AS)**	1
4.	**Explicit citation formats (CF)**	2
5.	**Personal voice embedded among others avoiding plagiarism (PV)**	2
6.	**Readability (RD)**	3
7.	**Conceptual clarity (CC)**	3
8.	**Presenting and socializing drafts of a project (PSD)**	3
9.	**Coherence (CH)**	4
10.	**Utilizing theoretical frameworks of the class to collect and interpret data and make decisions to improve data collection (TFD)**	5
Total		25

The two most frequent writing expectations for assignments were: a) utilizing theoretical frameworks of the class to collect and interpret data and make decisions to improve data collection (5 occurrences), and b) coherence (4 occurrences). An illustrative case of the writing expectation "Utilizing theoretical frameworks of the class to collect and interpret data and make decisions to improve data collection (TFD)" emerged from "Physics 3" enrolled in 5th semester in the methodology section of the syllabus:

Example 8
Applying theoretical frameworks when writing lab reports as a learning assignment

> ***4. Methodology***
> *The student:*
> *In the laboratory practices, he [the student] knows the theoretical foundations and the procedures to follow; he makes data collection, draws graphics, interprets results, makes indeterminacy calculations, proposes solutions, identifies error causes, and proposes error minimizing techniques.*

An example of the writing expectation “coherence” appeared in the general objective of the syllabus of the senior class “Technology Management”:

Example 9
Coherent and clear oral and written communication as a learning expectation

2.1. General Objective
By the end of the course, the student (...) will work cooperatively in teams and utilize coherent and clear oral, written and graphic communication

The next more frequent mentions of writing expectations for assignments were: a) presenting and socializing drafts (3 occurrences); b) conceptual clarity (3 occurrences); and, c) readability (3 occurrences).

The analysis of the distribution of the writing expectations associated with assignments that are overtly stated by the sections on activities and assessment of the syllabi suggests that there are classes without presenting these types of expectations (i.e., Basic design in engineering, Systems thinking, Ethics, Integral logistics, Method Engineering, Plant design, and Project management).

The analysis also reveals that the mentions about “utilizing a personal voice embedded among others but avoiding plagiarism” emerged only once in 8th semester in the class “Finance and budgets” for the evaluation section:

Example 10
Developing the own voice while avoiding plagiarism as a mastered writing knowledge

5. Evaluation
To assess learning, clarity and thoughtful usage of learning concepts are expected from the students. Critical thinking is expected along with presenting theoretical frameworks acquired in the class to conduct truthful economic analysis

Furthermore, “presenting and socializing drafts” is stated by the syllabi in freshman and senior years (the freshman classes Introduction to Engineering 1 and 2, and research seminar enrolled between semester 7 and 8). For instance, in the section of activities of the freshman class “Introduction to Engineering 1”:

Example 11
Presenting progress reports as class activities

5. Activities, Key Exercises, Means and Resources *Key Exercises* *The Transversal Work to the Course (TTC in Spanish) is the key exercise and main academic product that articulates knowledge and learning. To do so, two papers and progress reports will be presented; the final paper, the construction of a model for solving the problem applying the CDIO initiative, and an oral presentation of the whole process to a public. This TTC is carried out by work teams of 3 or 4 engineering students.*

Finally, “conceptual clarity” is mentioned in junior and senior years (in the classes Democracy and Colombian Constitution, and Finance and Budgets).

The analysis of the mentions of writing expectations for assignments confirms that expectations on writing and other forms of communication are neither constant nor progressive over time.

2.2.5. Ways of doing and thinking related to visual communication

Table 5 reports seven types of mentions of ways of doing and thinking related to visual communication and the total amount of mentions across the syllabi.

Table 5
Amount of mentions and types of doing and thinking related to visual communication

	Ways of doing and thinking related to visual communication	Occurrences
1.	**Graphic representations to summarize readings (GRSR)**	1
2.	**Interpreting symbols in diagrams (SD)**	1
3.	**Interpreting symbols in floor plans (FP)**	1
4.	**Expressing ideas graphically (EG)**	2
5.	**Depicting data collected from labs to interpret results (DDLI)**	3
6.	**Tables and graphics to plan and make decisions (TGPM)**	5
7.	**Visual communication to represent solutions of problems (SP)**	5
Total		18

The two most frequent expectations were utilizing a) visual communication to represent solutions of problems (5 cases); and, b) tables and graphics to plan and make decisions (5 cases). An example of the expectation "visual communication to represent solutions of problems" emerged in the section of specific goals of the syllabus of the class "Integral Logistics" enrolled after the 5th semester:

Example 12
Depicting company situations as a learning goal

> ***2.2. Specific Goals***
> *Solving situations and depicting a diagram of the logistic system of an enterprise by identifying its strengths and proposing solutions to increase the Colombian enterprises profitability and competition. All of this will be done along with the development of abilities that allow students to fully use the Integral Logistic.*

Regarding the learning expectation "tables and graphics to plan and make decisions", the following case was identified in the section of the general goal of the syllabus of the class "Management and quality control" enrolled in 7th semester:

Example 13
Using graphic and numeric models to make decisions in company situations as a learning goal

> ***2.1. Overall Goal***
> *Presenting introductory concepts of assurance and quality management by focusing primarily on analytic and computer tools for developing quality statistic controls in a productive system. The student starts with a good mastering and knowledge of the statistics techniques applied to engineering processes, and then moves to analyze results through graphic and numeric methods that help to make decisions in ongoing improvement processes. Along with numeric models, there are the oriental continuous improvement philosophies, such as Just in Time, the five S, Kaizen, Zero Waste and Pakayoke.*

There are syllabi across semesters that have no expectations on this issue, such as Systems Thinking, and Finance and budget. This is important to mention, since the interviews with faculty members revealed that senior students are expected to integrate linguistic and non-linguistic resources in conducting their senior theses.

Overall, the analysis shows that since freshman classes, students are expected to express ideas graphically by utilizing graphics to summarize, make decisions, and represent problems. Since junior courses, students should learn how to interpret standardized symbols that depict information of business and industrial processes and practices, and to create data in labs (e.g., the classes Method Engineering after 5th semester, and Plant design after 6th semester).

2.3. Summary

The analysis of the syllabi reveals that the students of this major need writing and other ways of communication to learn during the classes (47% of the mentions are ways of doing and thinking related to writing or other forms of communication) (table 3).

The analysis suggests that there is no overt pattern across semesters regarding specific growth or changes across time for different types of writing and communication practices, such as, bounding engineering problems in companies and proposing solutions by writing reports; writing for developing a personal voice respectfully among others' vantage point to write a literature review; scientific practices by depicting data collected from labs to interpret results; or, professional practices such as using graphic strategies to represent solutions of engineering problems. There is no a pattern either for the amount of ways of doing and thinking that count as learning expectations. In fact, the analysis shows that in the extremes of the program, there are classes (introduction to engineering in freshman year, and a research seminar in senior year) that embrace many expectations that might be difficult for students to achieve when analyzing the amount and types of expectations against the time period in which the courses are undertaken (17 weeks), and when compared against the amount of expectations across semesters..

The ways of doing and thinking identified in the sample confirm that the epistemology of the major is associated with solving problems by working collaboratively in companies under principles of productivity and profitability (e.g., by selecting materials and procedures efficiently based on budgets, raising resources and funding, standardizing procedures, and implementing control and management strategies).

The qualitative presence of ways of doing and thinking related to writing reveals that there are different epistemologies (systems of values) associated with writing practices across semesters. For instance, in freshman years a FYC class advocates for embracing reading and writing as a collaborative process in which meaning can be negotiated and created by working with others (the class is named “oral and written communication”); however, during the same freshman year, there are classes in which students should learn that writing is associated with standards and protocols/formats (the classes are named “introduction to engineering 1 and 2”). Towards the senior year (in semester 7 and 8), a class titled “research seminar” introduces the students once again to values related to reading and writing that they were exposed to in the FYC class, namely, “writing implies prior and careful reading”, and “writing should be addressed as a process”; however, in this class also the students are expected to understand relationships among formants/conventions, mechanics, and intended audiences when writing a senior thesis.

The “systems of values” (epistemologies) of the classes are primarily tied to the content knowledge of the classes, since the ways of doing and thinking related to writing that were identified suggest that the students should apply content knowledge by making claims in the assignments through the lenses of the theoretical frameworks of the courses.

The overall analysis of the ways of doing and thinking related to writing reveals that the students are mainly writing in every class for applying knowledge through case study reports, but towards the end of the program they are expected to write and complete the senior thesis requirement, which requires them to being able to make decisions to lead and propose institutional changes in companies to improve processes and profits of organizations while integrating linguistic and non-linguistic resources to convey their professional performance. This suggests that the students are exposed to two different systems of values across the semesters: a) one system that values meaning creation by negotiating with others and in which standards/conventions seem not play a central role (particularly in freshman year); and, b) the other system in which standards/protocols and conventions seem to be highly valued. This analysis also shows that at least two different systems of values are associated with types of writing assignments, one system that is related to writing for applying knowledge through cases studies, and the other associated with writing to conduct a senior thesis.

The analysis of writing presence as part of pedagogical strategies and assessment reveals that writing for testing is the most common practice; however, the analysis also confirms that the “report” is the type of genre that is most frequent associated with writing practices for assessment (either for cases studies or labs). Furthermore, this analysis confirms once again the presence of different systems of values associated with writing; for instance, “writing for developing a personal voice respectfully among other vantage points” is only present as an expectation in the FYC class, as well as “writing to analyze readings”, which is also an expectation in the research seminar that prepares students for writing a senior thesis in between semesters 7-8 of the major; whereas expectations on “writing for reporting cases studies”, and to “solve and report problem-solving” are more present and distributed across the semesters.

Writing expectations associated with assignments were not present in some of the sections of the activities and assessment in the template of the sample. This suggests that stating explicitly the assessment criteria for the assignments is not a common practice in the major. The distribution across semesters of the types of writing expectations associated with assignments reveals that an overt focus on avoiding plagiarism is stated by syllabi in freshman and senior classes. Expectations on visual communication learning were no present either in some syllabus. When these types of expectations were identifiable, the analysis reveals that visual communication is primarily used for representing solutions of problems and to make decisions.

Overall, this analysis reveals that writing and other semiotic systems emerge as part of ways of doing (methodologies), and ways of thinking (ideologies) that engage students in different writing epistemologies that might become contradictory (e.g., one system that is valuing meaning creation by negotiating with others, and the other that is emphasizing standards/protocols and conventions). In turn, such epistemologies embrace practices that are not considered throughout the syllabi as growth or change over semesters for different practices with writing and communication in the field (e.g., bounding engineering problems in companies and proposing solutions by writing reports; writing for developing a personal voice respectfully among others' vantage point to write a literature review; scientific practices by depicting data collected from labs to interpret results; or, professional practices such as using graphic strategies to represent solutions of engineering problems). However, the tendency is to utilize writing primarily related to solving problems by standardizing processes in companies and aiming at achieving profitability and productivity in such organizations. The type of genre "report" seems to be the most frequent format that embraces these systems of values. Furthermore, the analysis of writing presence for learning and assessing suggests that students are not necessarily exposed to explicit assessment practices that make them to gain awareness of the expectations, including expectations on learning/developing semiotic systems of representations other than verbal systems.

E. *Expectations on writing and communication in a Colombian major in Industrial Engineering*

The analysis of the learning expectations from the faculty members interviewed and the syllabi reveals ways of thinking and doing that are expected from students in a Colombian program in Industrial Engineering. This analysis provides descriptions of learning expectations with special attention to writing and non-verbal communication from which additional research might be conducted to explore "threshold concepts" in the major; that is, "troublesome knowledge" necessary for students to progress according to learning expectations across subject matters of curricula (Meyer, 2008; Baillie & Johnson, 2008; Meyer & Land, 2013).

Writing expectations in learning about the field

The analysis of learning expectations reveals that in this major the students are expected to learn about content knowledge through writing "reports", "cases studies", and "senior thesis"; moreover, students should perform "good writing" in assignments by deploying "conceptual clarity" and "coherence among paragraphs".

The most frequent "way of doing" inferred by this analysis (i.e., "Making claims to analyze case studies based on theoretical frameworks of the class") suggests that writing case studies is an important means to help students to gain ownership of concepts; in so doing, students might master content knowledge as "discourse entities" (e.g., knowledge domain constructed by language) (Meyer & Land, 2013). The analysis also confirms that after taking exams, writing reports for labs, cases studies, and even for a senior thesis is the most frequent pedagogical strategy to help students in making sense of the subject matters as "discourse entities" (Meyer et al., 2008).

Writing expectations in becoming a practitioner

Regarding writing to become a practitioner, the analysis discloses that students should articulate verbal and non-verbal systems (i.e., tables and graphics) to analyze problems and make decisions in companies, or depict information of business and industrial processes; additionally, the analysis of these expectations confirms that becoming a practitioner in industrial engineering entails making decisions based primarily on budgets and efficiency. This ideological feature of the major might confirm that is a business-oriented program, which is also related to the expectation regarding "senior theses open job opportunities for students"; this latter, in turn, is associated with local features of the economy that indicate that practitioners will be likely professionals on sales businesses.

The analysis reveals the presence of at least two systems of values (ways of doing and thinking) associated with writing practices: one system that is valuing meaning negotiations and the other one that is praising standards/formats. Although, they might be contradictory, this coexistence is an opportunity for students to see differences, since developing a strong disciplinary education in terms of only reinforcing ways of knowing and doing of a specific community might progressively diminish ability to see variations across communities (Meyer et al., 2008). Therefore, further research might be conducted to investigate how and when students deal with these types of contradictions for integrate knowledge, if happens, by making comparisons among prior, concurrent, and new writing situations.

Concerning the systems of values associated with writing practices that praise standard/formats, the following specific professional genre practices were identifiable in the analysis: “writing standards and guidelines manuals”, and “mastering an engineering protocol for projects”. Therefore, an additional analysis is important to explore to what extent these professional genre practices are expectations of the discourse community (Beaufort, 2007). Furthermore, additional analysis might be conducted to explore faculty members’ awareness on features of professional genres, since acknowledging interaction between writing and the domain knowledge of the field might complicate assumptions that deem writing as a universal skill (Adler-Kassner, Majewski & Koshnick, 2012).

Variation of writing expectations across curriculum

This analysis also reveals that there are explicit expectations on writing at the extremes of the program: in the freshman year (in the classes FYC and Introduction to engineering 2), and in the senior year (research seminar to prepare on senior thesis writing), but there is no overt connection between these two learning moments and expectations; that is, there are two different learning expectations to freshman writing in two different classes (writing by negotiating meanings with others vs. mastering an engineering protocol for projects), and in the senior year the expectations are mainly related to learning about senior thesis writing.

The analysis of the ways of doing and thinking of the FYC class suggests that writing is associated with “prior and careful reading”, and “meaning is created by negotiating ideas with others”. However, during the same freshman year, there are other disciplinary classes in which practices of professional writing are expected (“Writing Standards and guidelines manuals” and “Mastering an engineering protocol for projects”). During this first year, at least three courses are sharing expectations regarding the following practices: “Reading bibliographic resources carefully”; “Writing implies prior reading and intertextuality”; and “Addressing writing as a process”. Towards the end of the program, between semester 7 and 8 in the research seminar that is focused on writing a senior thesis, the following freshman expectations emerge once again: “Addressing writing as a process”, “Writing implies prior reading and intertextuality”, and “Reading bibliographic resources carefully”.

Regarding expectations on ownership and authorship, the analysis also reveals diverse practices expected in different times and spaces; for instance, in the FYC class, “Writing for developing a personal voice respectfully among others' vantage point”, while in the senior year, it is expected “a personal voice and critical stance based on theoretical concepts” in a class on finance and budgets, and in the research seminar is expected “a personal voice embedded among others while avoiding plagiarism”.

This simultaneous presence of systems of values associated with writing practices might need additional exploration to identify differences among curriculum moments (freshman, sophomore, junior, and senior). This analysis might aim at investigating how students conceptualize writing and gain awareness about social roles of writers in different learning moments (Dias & Paré, 2000; Brent, 2011), and how they develop authorship and ownership when are exposed to two systems of activity[36]: school-based writing and workplace writing (Dias et al., 1999).

The analysis conducted by semesters and across classes might suggest that there is not a developmental approach over time at least in the curriculum. The ways of doing and thinking identified seem not to be learning expectations of growth and change over time; for instance, students are expected to create data by measurements and reports but based on the sample analyzed, it is not possible to identify what might be different in creating data and its report in "Physics 2", semester 3, and in "Management and quality control", semester 7.

The data collected are not sufficient to explore expectations on change and growth for the following ways of doing and thinking in the major: "using graphic strategies to represent solutions of problems", "mastering an engineering protocol for projects", "creating standards and guidelines", "depicting companies graphically and holistically", and "interpreting symbols in floor plans and diagrams". All of these expectations are complex learning that might be better taught, assessed, and achieved by the students if understood as developmental learning. Similarly, there is no developmental recognition in expectations for students to learn how to perform as scientists by "depicting data collected from labs to interpret results", and as senior learners in the major by "writing as senior thesis as a process bounded by timelines, deadlines, and budgets" and by "following a format integrating linguistic and non-linguistic resources to convey a bounded problem and a professional solution accordingly".

This means that this analysis reveals variations of writing presence in this major but it is not enough to explore to what extent these students are aware of these variations in order to

36 Theoretical category to explain social activity and its organization/reproduction by making visible the overlap and natural contradictions emerging from the interaction between a) social goals of communities/groups and personal motives of individuals within and across organizations/communities/groups, with b) division of labor, social roles, hierarchies and power, systems of values, status quo vs. innovation, and access/creation of artifacts (either material or symbolic).

make generalizations while learning disciplinary concepts, in general, and developing their own writing theories, in particular. Therefore, additional analysis is necessary to trace the degree of difficulty of writing tasks over time and the scaffolding offered to the students accordingly (Beaufort, 2007). Particular attention should be paid to how the students of this major are developing their own theories about writing according to types of instructional environments (deadlines, different types of tasks, and feedback) (Lavelle, 2009).

This analysis does not explore either variations among classes and semesters regarding “the ways of doing reports” or “presenting reports”; this is, whether there are differences in writing for labs, cases studies of companies, or the senior thesis requirement. This is also the case for another way of doing and thinking identified as a trend in the analysis: “Making decisions to design and redesign to improve productivity and profitability in companies”; thus, additional analysis might be conducted to explore how evolve over time or semesters, students’ abilities for bounding problems and proposing solutions in companies.

F. Conclusion

This chapter offered insights that might inform writing curriculum design in a specific engineering subfield by including expectations of verbal and non-verbal writing (e.g., graphics, tables, or pics) and communication over time in a major in industrial engineering. Overall, this analysis reveals that writing and other semiotic systems emerge as part of ways of doing (methodologies), and ways of thinking (ideologies) that engage students in different writing epistemologies that might become contradictory (e.g., one system that is valuing meaning creation by negotiating with others, and the other one that is emphasizing standards/protocols and conventions); however, the tendency is to utilize writing primarily related to solving problems by standardizing processes in companies and aiming at achieving profitability and productivity in such organizations. The type of genre “report” seems to be the most frequent format that embraces these systems of values. Furthermore, the analysis of writing presence for learning and assessing in the courses suggests that students are not necessarily exposed to explicit assessment practices that make them to gain awareness of the expectations, including expectations on learning/developing semiotic systems of representations other than verbal systems that should be repurposed in conducting their senior theses.

The learning expectations created by this study is also useful to plan a research program on disciplinary writing development in this particular engineering subfield and the threshold concepts necessary to learn in this type of major. This research program might pursue the following agenda:

1- Studies on developing the following professional writing practices: a) Bounding engineering problems in companies and proposing solutions by writing reports; b) Writing standards, guidelines, and manuals; and, c) Mastering an engineering protocol for projects.

2- Studies on developing intertextual reading and writing practices to construct ownership and authorship in different genre practices: a) Writing for developing a personal voice respectfully among others' vantage point to write a literature review; and, b) Creating a personal voice and critical stance based on theoretical concepts to write case studies of companies.

3- Studies on developing abilities to articulate visual and verbal systems in two genre practices: a) scientific practices by depicting data collected from labs to interpret results; and, b) professional practices such as i) using graphic strategies to represent solutions of engineering problems, and, ii) depicting companies graphically and holistically.

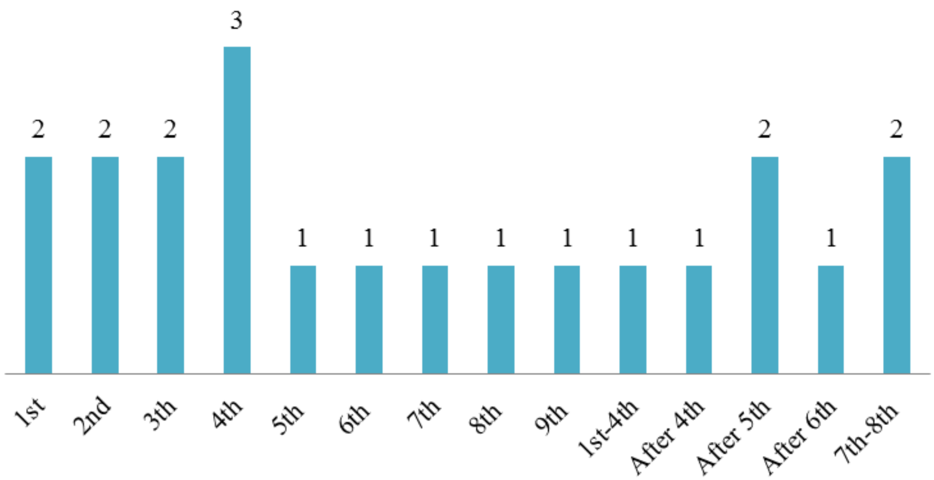
4- Studies on senior students' ability to integrate knowledge to write for the very first time, and probably only once in their lives, a senior thesis from which is expected that "an engineering process is bounded by timelines, deadlines and budgets" and "following a format integrating linguistic and non-linguistic resources to convey a bounded problem and a professional solution accordingly".

Ultimately, the analysis conducted, especially relied on the syllabi, might offer a methodological approach to be replicated by other writing advocates to explore systems of values stated through curricula that are related to writing and other semiotic systems; this approach included the following categories: a) Ways of doing (methodologies to become a practitioner or learn a discipline) and ways of thinking (system of values/ ideologies); b) Writing as a way of doing in the field as part of the methodologies of practitioners or as learning means in the classes; c) Writing presence (verbal and non-verbal) in learning and assessing contents; d) Writing expectations of assignments; and, e) Expectations on visual communication learning. Such methodological strategy contributes in the agenda of Writing Studies to describe developmental expectations of ways of doing and thinking in disciplines as an interdisciplinary domain between writing specialists and disciplinary instructors. This type of analysis is a crucial stage in envisioning initiatives on disciplinary writing and interdisciplinary dialogues with practitioners of other fields, as well as in planning research agendas on disciplinary writing development such as the one just described in this final section.

Appendix 1
Survey protocol

Section	Questions	Justification
Introduction	Your participation is voluntary and your responses will not be released to your instructors; therefore, your grades for this class or your overall performance in this Program will not be affected. You have the right not to answer questions you think are asking personal issues.	
General information	1. Admission year 2. Gender (F/M) 3. Day student (Y/N) 4. Major name 5. Why are you studying this program? 6. Have you worked in a project/job related to engineering? (Y/N) 7. Are you working currently in a project/job related to engineering? (Y/N)	Factors that might impact how students describe their writing experiences and reutilize knowledge to write (1-7)
Descriptions of writing experiences	Select an assignment or another project you have done in your program that was a writing experience. Describe the experience as follows:	
	8. Name of the writing assignment 9. Topic of the writing assignment 10. Number of pages 11. Name of the class 12. Semester and year	Situational factors associated with the writing experience (8-12)
	13. What is the relationship of the assignment with the class? 14. What was the instructor's goal? 15. What you learned from that experience? 16. What advice you would give to incoming students to face the same assignment?	Exploring how students make sense of the writing experience (question 13-14-15) What students can grasp/learn about the experience (questions 15-16)
	17. Select if the writing experience you described was positive _____ or negative ______ Justify your answer with at least 1 reason	Reasons to regard the writing experiences as positive in the program (question 17)
	18. Is this assignment similar to others you had done in other experiences in the program? Yes No If so, please provide the following information: Name of the experience: Topic: 19. Is this assignment similar to others you had done in other experiences in the program? Yes No If so, please provide the following information: Name of the experience: Topic:	Exploring knowledge that students can reutilize (retrospectively, laterally, and forward) in writing experiences (questions 18-19)
Further participation	If you decide to further participate voluntarily in this project, please provide your name, personal e-mail, and mobile. I will contact you to conduct interviews and ask you to provide writing samples of your assignments	

Appendix 2
Amount of classes mentioned by the survey participants by semesters



Appendix 3
Examples of grounded categories of ways of doing and thinking

Ways of doing methodologies to become a practitioner or learn a discipline	# of the case	Name of the class	Semester	Original fragment of the syllabus	Interpretation into English
Making measurements and creating data (CD)	3	Physics 2	3	METODOLOGÍA El profesor: Instruye al estudiante para la realización de las prácticas de laboratorio y utiliza esta actividad para validar las leyes físicas, y para que el estudiante desarrolle ingenio y habilidad en la toma de datos y en el manejo de los equipos de medida.	**Methodology** The teacher He instructs the student towards the laboratory practices and uses this activity to show the validity of the physics laws. He also uses the practices to allow the students to develop creativity and ability in the data capture and the measuring computers management.
Ways of thinking System of values/ ideologies	**# of the case**	**Name of the class**	**Semester**	**Original fragment of the syllabus**	**Interpretation into English**
Information management	14	Introduction to Engineering 1	1	OBJETIVO GENERAL Orientar a los ingenieros e ingenieras en formación de los programas de Ingeniería ofertados por la Facultad, para que tomen conciencia sobre su proceso de compresión del quehacer profesional mediante el conocimiento, aplicación y articulación de conceptos, métodos y técnicas, y comportamientos en relación con el manejo de información y los procesos de comunicación verbal y gráfica que les permita dar solución metódica, creativa y colaborativa a problemas de Ingeniería de alcance restringido que satisfagan necesidades de una determinada comunidad en un contexto determinado o den respuesta a la curiosidad sobre un tema determinado.	**Overall Goal** Orienting engineers enrolled in the engineering programs of the Faculty, so that they recognize through the knowledge, implementation and articulation of concepts, methods, techniques and behaviors, their comprehension process of their professional endeavor. All of this has to be done in relation to the data management and the graphic and verbal communication processes that will provide them a methodic, creative and collaborative solution to problems of restrained engineering, that will satisfy a certain community needs or answer to the curiosity about a certain topic.

Appendix 4
Examples of grounded categories of ways of doing and thinking related to writing or other communication abilities

Learning expectations related to writing or other communication abilities	# of the case	Name of the class	Semester	Original fragment of the syllabus	Interpretation into English
Mastering an engineering protocol for projects (EP)	15	Introduction to Engineering 2	2	OBJETIVOS ESPECIFICOS Apropiarse de un protocolo o metodología para formular proyectos de Ingeniería en forma rigurosa y sistemática.	**Specific Goals** To appropriate a protocol or methodology, in order to formulate engineering projects in a systematic and rigorous way.
Depicting graphically and holistically companies (DGHC)	13	Engineering methods	After semester 5th	OBJETIVOS ESPECIFICOS Utilizar los diferentes diagramas para el registro de procesos de manufactura y de servicios para efectuar mejoras en los procesos productivos en las organizaciones.	**Specific Goals** To use the different diagrams in the register of manufacture and services processes to make improvements in the productive processes of the organizations.
Writing a senior thesis proposal (WSTP) **Mastering a standard citation format [ICONTEC] (SFC)**	20	Research seminar	8	OBJETIVO GENERAL Estructurar e integrar adecuadamente los elementos de un anteproyecto de grado, para lograr expresar de forma clara una situación problemática y el cómo podrá lograr su solución, considerando la utilización de técnicas de redacción y estilo y normas Icontec[37].	**Overall Goal** To accurately structure and integrate the elements of an undergraduate draft, in order to clearly express a problematic situation and how it could be solved, considering the use of writing techniques, the style and Icontec standards.

37 These standards are defined by The Colombian Institute of Technical Standards and Certification (ICONTEC), which is a profit private Colombian organization that oversees the compliance of national and international standards. ICONTEC accredits organizations, companies and individuals that engage in the manufacturing or development of products and industrial processes. ICONTEC is a member of the International Organization for Standardization (ISO). Information taken from: "Colombian Institute of Technical Standards and Certification, ICONTEC." Wikipedia. Wikimedia Foundation. Web. 21 Sept. 2015. <https://en.wikipedia.org/wiki/ICONTEC>.

Appendix 5

Examples of grounded categories of writing expectations (verbal and non-verbal) for learning and assessing contents

Writing expectations (verbal and non-verbal) associated with assignments	# of the case	Name of the class	Semester	Original fragment of the syllabus	Interpretation into English
Writing to report case studies (WRCS) **Writing to report readings and observations WRRO**	1	Democracy and Political Constitution	1-4	**1.** METODOLOGÍA La Metodología tiene como propósito desarrollar en los estudiantes competencias de diferenciación y recomposición, de análisis y síntesis, interpretativas, argumentativas y propositivas. Para lo anterior, se considera conveniente trabajar desde una pedagogía afectiva y constructivista, para promover en el estudiante competencias socio-afectivas y desde el conocer, el sentir y el comunicar. Se adoptará una propuesta anclada en el Aprendizaje Basado en Problemas, estudios de caso y aprendizaje por proyectos. Desde allí la clase será un espacio interactivo e investigativo donde se analizarán problemas de carácter constitucional. Se podrán utilizar las siguientes rutas didácticas: ➢ Estudios de casos y testimonios ➢ Informe sobre conferencias, charlas de invitados especiales	**1.Methodology** The methodology plans to develop differentiation and redrawing, analysis and synthesis, interpretation, argumentation and proactive competences in students. For this, affective and constructivist pedagogies are implemented to promote socio-affective competences in the students from knowledge, feeling and communication. A proposal anchored to the Problem Solving Learning framework, case studies and Project-based Learning will be adopted. From now on, the class will be an interaction and research setting where constitutional problems will be analyzed. The didactic routes below could be followed: ➢ Case studies and witnesses ➢ Conferences report, special guests talks
Writing to report readings and observations (WRRO)	3	Plant design	After 6th	**2.** METODOLOGÍA La materia se dictara con: • Laboratorio de Diseño de Planta. • Clases magistrales. • Visitas empresariales. • Exposición del trabajo.	**2. Methodology** The subject will be addressed through: • Plant Layout laboratories • Master classes • Business visits • Work presentation
Writing to report case studies (WRCS) **Writing to report readings and observations (WRRO)**	10	Project management	8	METODOLOGÍA El curso se desarrollará en tres módulos temáticos, empleando para ello diferentes metodologías participativas que incluyen clases magistrales, participación activa de los estudiantes a través de ejercicios vivénciales, proyecciones de video, mesas redondas, talleres y trabajos de aplicación de casos reales, trabajos de investigación, presentaciones orales, informes de lecturas y una aplicación práctica de conocimientos mediante casos	**Methodology** The course will be developed in three thematic units with different participative methodologies including master classes, active participation of students through experiential exercises, videos, round table, workshops and real cases works, research projects, oral presentations, reading reports and a practice application of knowledge through cases taken from the organization, besides tutorships for students.

				tomados de la organización, así como tutorías para los estudiantes.	
Verbal writing and non-verbal writing to make decisions (WMD)	2	Basic design in engineering	3	OBJETIVOS ESPECIFICOS Reconocer y aplicar métodos y técnicas para la identificación y traducción de necesidades y requerimientos del cliente en especificaciones técnicas del diseño en ingeniería. Apropiarse de y aplicar un proceso de desarrollo conceptual estructurado y concurrente para producir diseños que den solución a un problema en el ámbito de Ingeniería. Identificar, apropiar y utilizar diferentes tipos y lenguajes de diseño en Ingeniería para generar, representar y comunicar estratégicamente conceptos, alternativas y modelos físicos y funcionales del diseño.	**SPECIFIC GOALS** To recognize and apply methods and techniques to identify and translate needs and requirements of the client in technique specifications of the engineering design. To appropriate and apply a structured, conceptual and concurrent development process to produce designs that can solve engineering problems. To identify, appropriate and use different engineering design types and languages to strategically generate, represent and communicate concepts, alternatives and physical and functional models of design.

Appendix 6

Examples of grounded categories of writing expectations (verbal and non-verbal) for assignments

Writing expectations (verbal and non-verbal) associated with assignments	# of the case	Name of the class	Semester	Original fragment of the syllabus	Interpretation into English
Presenting and socializing drafts of a project (PSD)	14	Introduction to engineering 1	1	ACTIVIDADES, EJERCICIOS CLAVES, MEDIOS Y RECURSOS Ejercicios Clave El ejercicio clave y principal producto académico articulador de saberes y aprendizajes es el Trabajo Transversal al Curso (TTC), dentro del que se tienen contemplado 2 entregas y socializaciones en clase de los informes de avance, elaboración de un documento final, construcción de un modelo de la solución propuesta al problema configurado aplicando la iniciativa CDIO, y sustentación oral en plenaria dando cuenta de todo el proceso. Este TTC es realizado en equipos de trabajo integrados por 3 o 4 ingeniero(a)s en formación.	**Activities, Key Exercises, Means and Resources** Key Exercises The Transversal Work to the Course (TTC in Spanish) is the key exercise and main academic product which articulates knowledge and learning. For this, two papers and socializations in the class about the advancements report will be presented; also there will be the making of the final paper, the construction of a model for solving the problem applying the CDIO initiative, and an oral sustentation of the whole process to a public. This TWC is done in work teams conformed by 3 or 4 engineers in formation.
Explicit citation formats (CF)	15	Introduction to engineering 2	2	3. ORGANIZACIÓN DE CONTENIDOS 8. Semana: Análisis de factibilidad del proyecto: Estudio de ingeniería del proyecto (selección de tecnología y equipos, flujo de recursos requeridos e infraestructura de producción). Manejo de citas y cotejación de textos. Lectura Básica: El Estudio de Ingeniería del proyecto. Técnicas para escribir citas y para hacer cotejación de textos.	**3. Content Organization** Week 8 Project feasibility analysis: Engineering study of the project (technology and equipment selection, resources flow and production infrastructure). Quotation management and texts collation. Basic Reading: The Engineering Study of the project. Techniques for writing quotes and for collating texts.
Personal voice and critical stance based on theoretical concepts of the class (PVCSBT)	6	Finance and budgets	7-8	5. EVALUACIÓN Hacen parte de la evaluación la claridad y profundidad de los conceptos obtenidos por el estudiante, su pensamiento crítico capaz de ser sustentado sin dejar a un lado los conceptos teóricos necesarias para un análisis económico veraz, al igual que su interés y presencia en las actividades programadas a lo largo del curso.	**Evaluation** The evaluation is constituted by the clarity and depth of the knowledge acquired by the students, their critical thinking able to be sustained without letting behind primordial concepts for a truthful economic analysis, and their interests and presence in the planned activities for the course.

Appendix 7
Examples of grounded categories of ways of doing and thinking related to visual communication

Expectations on visual communication learning	# of the case	Name of the class	Semester	Original fragment of the syllabus	Interpretation into English
Visual communication to represent solutions of problems (SP)	16	Integral logistics	After semester 5th	OBJETIVOS ESPECIFICOS Resolver situaciones y diagramar un sistema logístico de una empresa, identificando sus fortalezas y proponiendo soluciones para contribuir al incremento de la competitividad y rentabilidad de las empresas Colombianas, desarrollando habilidades que les permita utilizar la potencialidad de la LOGÍSTICA INTEGRAL.	**Specific Goals** To solve situations and diagram the logistic system of an enterprise by identifying its strengths and proposing solutions to increase the Colombian enterprises profitability and competition. All of this will be done along with the development of abilities that allow students to fully use the Integral Logistic.
Interpreting symbols in diagrams (SD)	13	Method Engineering	After semester 5th	3. ORGANIZACIÓN DE CONTENIDOS 5. Semana: Primer Examen Parcial Diagrama de Proceso de Operaciones o cursograma sinóptico Definición Objetivos Símbolos utilizados Pasos para la construcción Cursograma analítico o diagrama de flujo del proceso. Tipo Hombre, material y máquina Definición Objetivos Símbolos utilizados Pasos para la construcción Lectura Básica: Capítulo No 2. Ingeniería Industrial: Métodos, estándares y diseño del trabajo. Niebel. Páginas 34 a la 38	**3.Content Organization** Week 5 First Partial Exam Operations Diagram or Synoptic Flowchart Definition Objectives Symbols Construction steps Analytic Flowchart. Man type, material and machine Definition Objectives Symbols Construction Steps Basic Reading: Chapter 2. Industrial Engineering: Methods, standards and work design. Niebel, pp. 34-35.
Tables and graphics to plan and make decisions (TGPM)	14	Introduction to engineering 1	1	3. ORGANIZACIÓN DE CONTENIDOS 5 Semana: CONCEBIR: Configuración y análisis del problema y planeación de su solución: Requerimientos, Restricciones y Criterios, Relaciones causa-efecto, Cronograma de actividades y Planeación de recursos. Lectura Básica: Elementos para la caracterización de un problema. Técnicas para el análisis de problemas mediante relaciones causa-efecto. Elaboración de diagramas de Gantt y planeación de recursos.	**3.Content Organization** Week 5 To conceive: Problem configuration and analyses and solution planning. Requirements, Restrictions and Criteria; Cause-effect relationships; Activities chronogram; and Resources Planning. Basic Reading: Problem characterization elements Techniques for problem analysis through cause-effect relationships. Grantt's diagrams development and resources planning.

IV. Chapter 4. Writing practices in accomplishing a senior thesis: accounts of academic and professional writing growth in a Colombian major of Industrial Engineering

Abstract

Senior theses in Engineering are opportunities for students to apply, outside of academic environments, knowledge learned in classrooms as evidence of their academic and professional growth. Preliminary data collected in fall 2013 through interviews with faculty of an undergraduate program in industrial engineering of a Colombian university confirms that a senior thesis is a culminating project and a written genre utilized to assess academic and professional growth of students. Faculty members also pointed out specific institutional constraints that might aggravate conducting and writing a senior thesis: a) the lack of negotiation among faculty regarding linguistic and non-linguistic contents expected from the reports; and, b) time limitations to guide and evaluate the projects. Therefore, this chapter creates accounts of academic and professional writing growth of students as novice practitioners of their field and contributes in identifying the role of verbal and non-verbal practices in accomplishing a senior thesis in this major. A survey of six final reports of senior theses shows that undergraduate students tend to address disciplinary concerns with specialist language to offer narratives of what they have done to address their professors as the main audience. One of the most frequent ways of doing and thinking inferred by the reports was "standardizing procedures" either for company situations or teaching practices in the field, and there might be a relationship between this professional practice and the most frequent "genre" mentioned in the sample: "guidelines". The analysis also reveals that in some cases visual artifacts count as strategies to think (writing to think), but not necessarily to display information that could be used persuasively in communicating with different stakeholders involved in the issue. This exploration ultimately confirms that a "senior thesis" is a genre that positions the student between conflicting systems of values related to writing and knowledge production. On the one hand, the senior students might have carried out academic writing and knowledge production (e.g., justifying their projects for the faculty of the major, and collecting information through interviews and surveys); and, on the other hand, the senior students might have created data as practitioners of the field (e.g., making measurements by calculating performances of old-timers and qualified workers and/or other stakeholders involved that might block the productive process under study).

A. Introduction

Senior internships are initial forms of membership that boost professional development through immersion in which learning takes place by doing in a community of practice. In senior internships, novices have less work with less responsibility than those who are full participants in the community (Lave & Wenger, 1991; Dias, & Paré, 2000); although some degree of professional growth is also expected from them to accomplish this learning experience.

Pedagogically speaking, senior theses in Engineering are opportunities for students to apply, outside of academic environments, knowledge learned in classrooms as evidence of their professional growth; therefore, a senior thesis is as a transitional experience between academia and workplace (Lekhakul & Higgins, 1994).

As a research site in Education, the senior thesis has been studied as a writing challenge, especially for students affiliated to programs in which writing might not be highly embedded in the disciplinary identity formation. In characterizing the challenges students face to accomplish a senior thesis, Arnoux (2011), for instance, points out the lack of guidelines and clear institutional polices; however, it is also suggested that writing these types of high-stake projects will be always a complex phenomenon. Tensions and discontinuities are expected resulting from the interaction among the overlapping motives of the involved participants and communities, such as departments, supervisors, personal student trajectories, and job-student expectations (Paré, Starke-Meyerring & McAlpine, 2011; Calvo, 2009; Britt & Beach, 2002).

Preliminary data collected in fall 2013 through interviews with faculty members of an undergraduate program in industrial engineering of a Colombian university[38] reveals that it is expected that senior students exhibit professional performances through proposals and reports of senior theses by making decisions to lead changes in companies to improve procedures and profits. In terms of deploying disciplinary knowledge through writing, the expectation is the students will demonstrate the ability to integrate linguistic and non-linguistic resources to convey their professional performance. Faculty members also pointed out specific institutional constraints that might aggravate conducting and writing a senior thesis: a) the lack of negotiation among faculty regarding linguistic and non-linguistic contents expected from the reports; and, b) time limitations to guide and evaluate the projects (the semester workload for tenured professors is 3 hours to evaluate reports and 12 hours to guide students). One of the interviewees stressed, for instance, that some faculty members are really fond of tables and graphics while others seem to prefer prose. Despite these discrepancies, this preliminary exploration through opinions of faculty members ultimately confirms that a senior thesis in this major is a culminating project and a written genre utilized to assess academic and professional growth of students through verbal and non-verbal systems (e.g., tables or graphics).

Therefore, this chapter describes academic and professional writing growth expected from the students as novice practitioners in conducting a senior thesis in a Colombian major of Industrial Engineering and contributes in identifying the role of verbal and non-verbal practices. Accordingly, a preliminary exploration of six final reports of senior theses in Industrial Engineering is presented to describe types of academic and professional practices related to genre production that might have been used by senior students in accomplishing their senior theses in this major.

[38] Five semi-structured interviews were conducted by Skype and audio-recorded in Spanish with faculty members affiliated to a Colombian university who accepted to participate voluntarily in the study.

B. Theoretical framework

In this study, a senior thesis is a culminating project that might be regarded as a genre for exhibiting academic and professional writing growth; thus, the theoretical framework is comprised of two sections: writing growth in college, and an overview of professional writing and communication in engineering. The latter has been important to create grounded categories for the analysis. Besides, the whole theoretical framework will be used later in the discussion section to describe academic and professional writing growth in a Colombian major of Industrial Engineering.

1. Writing growth in college years

According to Carroll (2002), writing development is the growth promoted by efforts of institutions, professors, and students themselves. Carroll's study “Rehearsing New Roles: How College Students Develop as Writers” found that students perceived that their writing did not necessarily improve over time but indeed is transformed in terms of formats and contents mostly due to the experiences they went through. Strikingly, students of this study selected as meaningful writing experiences those embedded in challenges and milestones for their personal growth such as living abroad, internships, and those in which innovative means of content circulation (digital portfolios or videos) were used. Ultimately, Carroll (2002) claims that rhetorical sophistication is achieved as a result of how students cope with the writing demands without formal instruction.

In other studies, writing development is tied to disciplinary identity development, and accordingly with mastering disciplinary and professional genres. Dressen-Hammouda (2008) studied how a novice field geologist evolves in producing a field report as part of his doctoral studies. The study claims that disciplinary identities draw on a wide range of unstated semiotic frames beyond linguistic modes (e.g., graphic signs, gesture, and conversations) that allow communicative interactions with specialist meaning among practitioners. This finding has two theoretical implications: 1) the meaning of a genre for specialists depends on the simultaneous elaboration of other semiotic resources; and, 2) materialized genres (linguistic, visual, graphic, gestural, or behavioral) and disciplinary identities are linked within a *semiotic chain* within a community of practice. Therefore, students´ growth as practitioners of a discipline depends on sharing semiotic resources and chains as well as materialized genres to develop ways of being, seeing, and acting as members of their field. Gaining familiarity and expertise in using those genres, including semiotic chains, is then considered an essential part of learning how to reproduce the disciplinary knowledge.

Dressen-Hammouda (2008) shows through the analysis of three fieldwork reports how the research participant develops his disciplinary identity while deploys rhetorical movements including semiotic chains:

- The text 1 written as a third-year undergraduate student reveals that the writer presents what he did rather than describing a "natural reality". He was providing a narrative as if were "a right answer" for the instructor.
- Text 2, a field account written at the end of the first year of his Master's degree, deploys a type of know-how in the discipline in which the student demonstrates mastering on describing fieldwork practices; however, the genre was not yet written to address other scientific readers to convince them that his interpretation was the most plausible to natural reality. As a result, his use of the implicit cues does not yet fully reflect the entire range of implicit

propositions that allow field geologists to establish their credibility and authority within the community.

- The final text was the basis for his dissertation research and publications. At this point, he held debates with the advisors about his interpretative framework, which was accepted for a publication. This final text was evidence that the student had definitely acquired a disciplinary voice and identity as geologist, at least at a ‘‘junior researcher’’ level, since his claims reached a wider disciplinary community, not just his instructors.

Artemeva (2009), furthermore, investigates growth between academia and workplace. Her study reveals the trajectories on learning professional genres of four novice engineers who also had taken a course on Technical Communication (ECC) led by the researcher. In this course, the students conduct a project design to enhance improvisation strategies and rhetorical flexibility. Artemeva (2009) claims that the following components contribute to the formation of professional genre knowledge: (a) agency, as reflected in the novice’s ability to both seize and create *kairotic* moments (rhetor’s ability to select and/or create an opportune moment to act proportionally) in the chronological flux of time to respond them proportionally, and enact genres in the ways that are recognizable by the community of practice; (b) cultural capital (i.e., particular cultural knowledge, such as engineering knowledge, or professional engineering competency); (c) domain content expertise; (d) formal education; (e) private intention; (f) understanding of the improvisational qualities of genre; and (g) workplace experiences.

This study provides evidence to claim that learning professional genres does not occur in smooth and uninterrupted ways, as Carroll (2002) suggests as well. Students accumulate genre knowledge throughout their lives from different experiences and encounters. Their cultural capital and private intentions have a profound effect on their development. The findings of Artemeva's study ultimately indicate that if domain-specific communication strategies are carefully teaching can serve as *one* of the ingredients of professional genre knowledge.

This section suggests that "writing growth in college" embraces different types of expectations. Some expectations are related to experiences that have impacted students' lives and identities; others related to the progressive and changing ability to create different audiences and types of claims by using academic genres throughout students' academic trajectories; and other expectations particularly associated with opportunities to create and be exposed to professional genres in the field of students' majors. Therefore, in the following section, specific professional writing and communication practices in engineering will be characterized, since the analysis aims at identifying practices of senior students as novice practitioners in industrial engineering while they conduct and write their senior theses.

2. Professional writing and communication in engineering

Some studies conducted in engineering workplaces confirm that writing is based on routines and cycles in order to diminish the workload of daily job life for the teams. Spinuzzi (2010), for instance, explored a marketing company in which specialists write up to 10 to 12 complex 20- page reports first week of each month. His findings suggest that writing is embedded in routines and cycles as ways of offloading work.

Winsor (1992) also claims that engineers value constraints in writing rather than originality and voice. Writing seems to be a highly standardized practice for engineering practitioners: i) the use of non-verbal writing; this visual and spatial reasoning is different than rational verbal conceptualization; and, ii) the use of passive voice as an evidence of how knowledge is produced by machines or standardized procedures.

These studies explain why engineers do not necessarily deem themselves as writers. Lloyd (2000) also found that engineering designers used storytelling as a narrative element, which allows sorting out and labeling situations to solve current problems and anticipate further similar situations in a company. This practice might be related to time management and efficiency in design processes through creating identities for products, services, or problems.

Furthermore, different types of rhetorical situations in which engineers participate as students and professionals are embedded in diverse systems of values and practices; these values and practices shaping writing and communication are tied to division of labor, access to materials/resources, hierarchies, and symbolic capital of corporations (Winsor, 2003; Spinuzzi, 2003; Lerner, 2009). In entrepreneurial environments, for instance, writing is done by different specialized groups according to the size of the companies. Some of the groups address marketing and technical issues; therefore, what is relevant for writing and reading organizational documents vary across stakeholders and within institutions (Winsor, 1996).

To describe practices of communication and writing in engineering within organizations, the following section primarily summarizes the work of Dorothy Winsor. Her work has shaped the field in Technical Communication in the U.S. (Read, 2011). One book, “Writing like an Engineer: A Rhetorical Education”, is based on the experiences of five students across their trajectories and transitions from college to workplaces, and the other one, “Writing Power: Communication in an Engineering Center”, is an analysis of how managers, engineers, technicians, and interns affiliated to a for-profit organization selected, created, and used different genres to generate, disseminate, and gauge expertise knowledge.

The study of genre knowledge within Rhetorical Genre Studies (RGS) highlights the development of professional identities and agency of genre users (i.e., individual opportunity to achieve personal motives) in workplace environments. People develop disciplinary identities through participating in professional practices that imply enacting roles in which genre actions are opportunities or not for professional identity development (Artemeva, 2009). Therefore, for scholars in RGS, becoming an engineer involves not only mastering disciplinary knowledge and practices but also achieving roles in organizations; thus, practitioners have to conform to organizational and professional genres (Winsor, 1996).

When conforming expectations of organizational and professional genres, practitioners might be unaware of the rhetorical nature of knowledge production; however, they create realities (certain type of knowledge) through organizational and professional genres for specific audiences affiliated to certain communities (acceptable knowledge in a community). In doing so, practitioners account for the part of the world that is their professional jurisdiction (either organizational or disciplinary, or both) to interact with different audiences (to persuade them). For instance, when internship students explain "good writing", they mention rhetorical decisions to address differently customers or managers. Similarly, entrepreneurial writing is done by different specialized groups; some of them address marketing or technical issues (Winsor, 1996).

To learn how to conform professional and organizational genres, freshman engineers are socialized through genres. Seasoned engineers expect that freshman students learn how to deal persuasively with data by providing feedback and genre samples. However, freshman students will make sense differently of the experience based on their prior conceptions on writing (Winsor, 1996).

Therefore, in socialization experiences, students may deal with conflicting values between writing experiences of schooling and professional contexts, although they ultimately will learn that both writing systems are different. Problems may appear if students are not prepared to value and understand differences of these two contexts and, eventually, mainly acknowledge writing practices of workplace environments (Winsor, 1996).

Acknowledging such differences may benefit the development of audience awareness. Interns develop audience awareness when they fulfill customers' needs by introducing rhetorical changes in documents and not only by "correcting grammar". Likewise, when interns write reports to supervisors only for accountability, they are basically doing “paperwork”; this suggests a lack of audience awareness and genre knowledge, especially because "reports" should influence corporate thinking about new projects (Winsor, 1996).

The lack of rhetorical and genre awareness of engineering students is also associated with assumptions about “data”. “Data” is an authoritative entity rather than a persuasive construct when it is seen as a technical construct; thus, “data” no needs explanations but makes claims by itself, especially, when audiences and genre users of "data reports" are the very same practitioners (Winsor, 1996). According to rhetorical analysis of entrepreneurial communication, engineers work with technical objects (devices) that will be documented or translated into texts (data reports). Even if technical objects are still in progress of construction, texts (data reports) that present such devices are regarded as fixed entities by genre users, since they provide information of technical objects without direct and physical observations. Moreover, the type of knowledge that is reported by documents is data created by machines without human intervention; thus, this knowledge production is valued as autonomous and trustful inscriptions that control human bias (Winsor, 2003).

When data is regarded as authoritative knowledge, genre users rely on the assumption that the knowledge source is also fixed. Under this conception, if data is a source of stable and reliable knowledge, users are not allowed to manipulate data to avoid jeopardizing its constitutive power. Therefore, persuasion for engineers means “manipulation” (Winsor, 1996).

However, engineers indeed interpret data rhetorically in documents to create a common ground, negotiate meaning, and achieve agreement in organizations (Winsor, 2003). “Relevant data” becomes a rhetorical construct derived from interactions among diverse audiences (engineers, technicians, and managers) and documents; thus, engineering writing is ultimately undertaken persuasively. Engineers are not aware of such persuasive nature of professional communication; instead, believing in self-evident data reinforces that professional communication and writing are a-rhetorical. Nonetheless, when engineers address their peers, audiences are persuaded by the logos of data and the ethos of impersonality (by using grammar and lexical terms of the field to talk as an insider); whereas if managers are the audiences, engineers are more willing to rely on personal authority to make claims. It seems that engineers become more aware of rhetorical features of communication and writing when they assume professional roles in management, since persuasion is a key component in interacting with other than peers (Winsor, 1996).

Since engineers can enact different roles within subgroups of organizations, writing and communication in companies is a phenomenon of “distributed cognition.” Engineers act in concert to accomplish a goal that otherwise is not achievable or is not possible to attain individually, which means that if a person is not able to accomplish the task, other people can help in a chain of complex and coordinating activities. The concept of distributed cognition implies one thinks in conjunction with other people either as a newcomer/apprentice in a community of practice, as a member of a collaborative team, or as a person responsible for the ultimate goal. Moreover, writing as part of "distributed cognition" implies that knowledge, language, and power are intertwined with activities undertaken by different groups within companies. This explains that engineering knowledge and management knowledge coexist in the same organization but are part of different authority systems (Winsor, 2003). Within this approach, genre-shaped texts are means to occupy/enact positions of power. Texts help to create "positions" from which they can operate; therefore, the interplay between types of documents and company positions of those who are producing the documents displays how accumulation and appropriation of capital (material and symbolic) might be centralized in certain hands in an engineering company (e.g., positions in the company that are in power to define and present budgets) (Winsor, 2003).

As a result, in researching about communication and writing in engineering, it must be acknowledged that the same organization can hold diverse communities/collectivities and even activity systems[39]. This explains why decisions made by participants/genre users in these communities and activity systems raise contradictions.

This second section of the literature review on communication and writing in engineering confirms the ideological dimension of writing in the profession, especially by highlighting

[39] Theoretical category to explain social activity and its organization/reproduction by making visible the overlap and natural contradictions emerging from the interaction between a) social goals of communities/groups and personal motives of individuals within and across organizations/communities/groups, with b) division of labor, social roles, hierarchies and power, systems of values, status quo vs. innovation, and access/creation of artifacts (either material or symbolic).

how communication practices that are created and maintained by oral and written genres through activity systems in organizations will participate in producing of both material and symbolic capital for positioning participants in a system of values and accessing (or not) to actual resources.

C. Sample and analysis

Preliminary data collected in fall 2013 through interviews with faculty members of an undergraduate program in industrial engineering of a Colombian university confirms that a senior thesis in this major is a culminating project and a written genre utilized to assess academic and professional growth from students through verbal and non-verbal systems. Faculty members also pointed out specific institutional constraints that might aggravate conducting and writing a senior thesis: a) the lack of negotiation among faculty regarding linguistic and non-linguistic contents expected from the reports; and, b) time limitations to guide and evaluate the projects. Therefore, this section presents a preliminary exploration of six final reports of senior theses in Industrial Engineering to describe types of academic and professional practices related to genre production that might have been used by senior students in accomplishing their senior theses in this major.

Six final reports of senior theses were downloaded from the institutional archive of the library of this Colombian university by the time the interviews were conducted. General descriptions of the sample are in table 1.

Table 1
The sample

# sample	Title	Year	# authors	Total pages
1	Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone	2012	1	94
2	Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*	2013	2	172
3	Analysis of games as teaching tools for teaching and learning on operations management area of the undergraduate program in Industrial Engineering	2013	2	176
4	Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study	2013	1	83
5	Designing procedures for a certification training center on safe work at heights for the company *EPI Ltda.* according to current regulations	2013	1	175
6	Analysis and proposal of production planning and control systems for a clothing manufacturer	2013	1	145
			Total amount of pages	845
			Average	140,83

To better understand the interplay between writing and professional practices undertaken by senior students in their theses, the analysis of the sample aimed at creating grounded categories to:

1) Describe a) types of problems/topics addressed by the reports, and b) types of business and companies associated with the senior thesis reports.
2) Infer ways of doing (methodologies to solve problems as practitioners of the field) and ways of thinking (systems of values/ideologies deployed by senior students in solving problems of the field) associated with the types of problems and solutions reported in the documents analyzed. A preliminary list of ways of doing and

thinking had been developed in a prior study about learning expectations deployed through syllabi in this very same major. Aiming at aggregating data, the same first list of categories was utilized to describe the sample of senior thesis and new grounded categories were added when emerged from the data (appendix 1).

3) Identify, when possible, information about the following categories that allow exploring writing embedded within activity systems:

Categories related to genre production from an activity system approach	**Description**
Professional genres mentioned	Names or labels used by the senior students to describe types of documents that developed as part of their senior theses in companies/organizations
Artifacts	Names of other documents (tables, graphics, surveys) or materials (pictures, software) that were mentioned by the students in the reports as part of creating the genre mentioned
Writing procedures	Activities led by the senior students in producing the genres or artifacts mentioned including the senior thesis report as an academic written genre
People involved in the production of the professional genres or artifacts	People other than the senior students involved in the production of the genre or artifacts mentioned (e.g., people from which information is collected or who are involved in collecting information)
People involved in approving the professional genres	People other than the senior students in approving the official use of the professional genres and artifacts mentioned

The literature reviewed for this study regarding professional writing and communication in engineering shows that it is important to describe professional practices related to genre production within the theory of activity systems. This approach has provided a framework for genre analysis to explore routines or typified interactions of reading and writing practices within and across groups/organizations/communities (Russell, 2010); this type of analysis helps identifying implicit practices of text production, distribution, or use, and sequences of documents in relation with activities pursued by groups/organizations/communities (Bazerman, 2003).

Before presenting the results, it is important to clarify that the senior thesis reports were not analyzed to assess its writing quality.

D. Results

1. Types of problems/topics and types of business and companies associated with the senior thesis reports

The analysis of the types of problems and types of business reported by the documents analyzed suggests that the students have written these senior theses as part of analyzing company situations (sample # 1, 4, 5, and 6) or learning processes in the field (industrial engineering) (sample # 2 and 3).

For instance, the following fragment is an example of a senior thesis titled: "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone", which was addressing a company situation: the need of standardizing a matrix to determine the exact amount of material needed in packaging items of a warehouse on a company Free Zone[40]:

Example 1
Title report: "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone" (2012)

> Abstract
> (…) Once the data collection was over, in some charts it was consolidated that through a formula and some calculations, every packaging material of a product ton was standardized. With this standardization, a matrix was developed with the purpose of allowing the warehouse operator in the Free Zone and the regulatory authorities to know the quantity of the packaging material used for boxing up tons of the final product.

[40] In this section some fragments of the senior thesis reports are used to illustrate the analysis. Since the original data is in Spanish, the cases were translated into English. These translations were done by *Ingrid Julieth Hernández Cuero,* senior student of the Degree in Foreign Languages of the *Universidad del Valle* in Colombia.

The next case, furthermore, is a fragment of an example of a thesis addressing learning processes in the field, "Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*":

Example 2
Title report: "Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*" (2013)

Introduction
(…)
Furthermore, master's degrees widen and develop knowledge to solve disciplinary, interdisciplinary, or professional problems and provide people with basic tools to conduct specific studies on sciences or technologies. Also, these degrees may allow people to deepen theoretically and conceptually about philosophy, humanities, and arts. The Industrial Hygiene and Security master's degree of the Autónoma de Occidente University is a specialized-oriented master program.

Expert competencies can be obtained through specialization and master's degrees. The Autónoma de Occidente University has as part of its graduate programs, the specialization and master in Industrial Hygiene and Security. This program offers tools for students to analyze and solve problems related to the workers security, hygiene, and health in workplaces. This project aims at designing and implementing laboratory practices and research guidelines for the ergonomics course in Industrial Hygiene and Security, specifically about movement, transportation, and pushing and pulling loads practices. It also includes body relations: anthropometrics (energy use) to offer a better training to solve daily routine industrial problems. Moreover, this project offers pedagogic tools for teachers to complement and facilitate students' training.

2. Ways of doing and thinking

Table 2 presents the list of ways of doing and thinking identified across the sample. For instance, the following senior thesis related to company situations and titled "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" implied the next ways of doing and thinking:

1. Calculating times and its costs in a production process.
2. Making decisions to design and redesign human resources expectations of companies.
3. Making decisions to design and redesign to improve productivity and profitability.
4. Making measurements according to norms and standards.

5. Making measurements and creating data.
6. Multivariable thinking to make decisions.
7. Solving problems methodically.
8. Standardizing procedures.

In a case of a senior thesis related to learning processes in the field, for instance, the report named “Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*”, the following ways of doing and thinking were inferred:

1. Analyzing company situation and procedures under legal standards
2. Making decisions to design and redesign on human resources expectations of companies
3. Making measurements and creating data
4. Making measurements according to norms and standards
5. Multivariable thinking to make decisions
6. Standardizing procedures

Table 2
Ways of doing and thinking inferred from the sample

Ways of doing and thinking	Occurrences
Making measurements and creating data	6
Standardizing procedures	4
Developing and implementing control and management strategies	3
Making decisions to design and redesign to improve productivity and profitability	3
Multivariable thinking to make decisions	3
Analyzing company situation and procedures under legal standards	2
Making claims to analyze case studies based on theoretical frameworks of the senior thesis	2
Making decisions to design and redesign on human resources expectations of companies	2
Making measurements according to norms and standards	2

Solving problems methodically	2
Addressing writing as a process	1
Bounding and defining engineering problems	1
Calculating times and its costs in a production process	1
Comparing business processes and performance to industry best practices from other companies	1
Training other workers	1
Working collaboratively	1

The number of mentions of the ways of doing and thinking identified suggests that the most frequent practices conducted by the senior students to accomplish their senior theses were "making measurements" and "creating data for standardizing procedures". For example, the report titled "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone", in the general objective displays as an example the goal of "making measurements":

Example 3
Title report: "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone" (2012)

> 3.2. Specific Goals
> 3.2.1. Collecting data of packaging material measurements for boxing up a final production. (…)

The following fragment of the senior thesis titled "Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*", displays as part of the results lab guidelines that support students in learning on "creating data for standardizing procedures" by also utilizing manuals of standards:

Example 4
Title report: "Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*" (2013)

> Laboratory Guide
> Manual Handling of loading, pushing and pulling loads
> Objectives
> a) Registering and analyzing information originated from the manual handling, transportation, load pushing and pulling from the workers' assumed positions according to the initial and final positions of the load, the height of the arms holding and moving the load, the grip level, the trunk movement regarding the ankles' position and the real weights to manipulate.
> b) Evaluating the manual load movement risks, through the application of the NTC 5693-1 method and the NTC 5693-2charts.
> c) Defining the control measures for the manual load handling and the pushing and pulling loads, taking into account the processes used for the estimation and valuation of the NTC 5693-1 risk. (…).

3. Professional genres mentioned

The mentions in the sample related to types of professional genres created by the senior students while conducting their senior theses suggest that the students were primarily creating "guidelines" to aim at different goals, such as, a) changing procedures; b) defining systems of planning and control; c) guiding lab practices; and, d) creating a training center on working at heights. Only in one case, one of the reports mentioned a genre named "matrix" for standardizing industrial procedures.

For instance, the senior thesis report titled "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" shows this goal of creating guidelines in the result section when defining systems of planning and control:

Example 5
Title report: “Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study” (2013)

> 16. Loading Description with the Improved Method
>
> 16.1. Loading Schedule
>
> The logistics coordination assistant assigns the loading shift to the articulated trucks of 18 to 35 tons for trucks of less than 10 tons and according to the commercial area income in the RCP (order forms) program, he enters the tons in the shifts’ software. Afterwards, he gives the printed order forms to the dispatch programmer.
> The tons entered in the Shifts’ software are verified to be the same as the ones provided by the Portico program and then the loading is scheduled.
> After verifying the tons for each truck, the person in charge logs in the accounting ENTERPRISE program and consults the order, checks the availability of the materials, and makes a referral. Knowing the needed materials for loading, with the help of the material data software, he joins the ERP with the Dispatch software and avoids the dispatch programmer from typing references, quantities, and all the clients’ information. He will only have to enter the driver’s name, the license plate, and it will automatically provide a theoretical weight. Then, the dispatch is printed and delivered to the driver or the dispatcher to load the truck. (…)

Another example of creating guidelines to conduct lab practices appeared in the proposal section of the senior thesis titled: “Analysis of games as teaching tools for teaching and learning on operations management area of the undergraduate program in Industrial Engineering”:

Example 6
Title report: "Analysis of games as teaching tools for teaching and learning on operations management area of the undergraduate program in Industrial Engineering" (2013)

10. Example of implementing and evaluating a Pedagogical Game Design

To design and implement a pedagogical game, it is necessary to carry a curricular work in which instructors of the same area discuss the formative purpose and the learning outcomes of the game. This process will foster general agreement.
To clarify the proposal previously described, the next example is provided:

10.1 Design and Implementation

Table 11. Example of design and implementation of pedagogical games

Format to design a pedagogical game **Faculty:** Engineering **Department:** Operations and systems	UNIVERSIDAD AUTÓNOMA DE OCCIDENTE Universidad AUTÓNOMA de Occidente
Subject: Operation Management II	Date: May, 2013
Title of the pedagogical game	
Push and Pull	
Topic: Inline production systems, Push and Pull and Kanban	
Design	
Students' profile	
Industrial engineering students enrolled in Operation Management II and approved Operation Management I	
Background	**Learning goal**
The students must know about inline production systems, Push and Pull, and Kanban system	• Learn concepts of Push and Pull • Identify advantages and disadvantages of production systems • Conceptualize Kanban system
Competences	
General	**Professional**
• Solving problems • Oral, written, and graphic communication • Critical thinking	**Manufacturing area:** • Identifying, proposing, and solving problems related to control and production management by considering tools and methodologies of production and management and the use of information systems • Determining and distinguishing Pull and Push as relevant concepts of production systems • Listing and describing advantages and disadvantages of production systems • Explaining the concept of Kanban production to develop improving strategies for inline

4. Artifacts

The artifacts (i.e., names of other documents such as tables, graphics, surveys, or materials such as pictures, and software) that were mentioned by the students in the reports as part of creating the genres just described are summarized in table 3.

Table 3
List of artifacts mentioned in the reports

# sample	Title	Genre mentioned	Artifacts
1	Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone	Matrix	1. Data sheets 2. Software developed by the Department of planning and production 3. Tables to summarize and collate data
2	Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*	Lab guidelines	1. Content knowledge and its categories are explained by using visual diagrams to create hierarchies 2. Guidelines that offer instructions for collecting data and reporting and analyzing the lab experience by writing 3. Guidelines with instructions for students to learn what materials and procedures must be followed to create data 4. Images are used to introduce the lab guideline 5. Lab supplies 6. The actual lab supplies and materials in the lab of the university 7. Legal documents with standards 8. Theoretical framework at the beginning of the guideline with citations to contextualize the concept that will be practiced in the lab
3	Analysis of games as teaching tools for teaching and learning on operations management area of the undergraduate program in Industrial Engineering	Lab guidelines for lab practices	1. Creation of simulated situations and environments of production units to collect and create data 2. Designing a survey 3. Designing graphics to summarize survey results
4	Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study	Creating a guideline for changing procedures	1. A diagram to depict the stages of loading and shipping processes 2. A diagram to identify causes and effects (fishbone) 3. A graphic called "problem tree" is used to describe, categorize, rank, and articulate company problems 4. A map of the warehouse 5. A video is recorded to register how shipping processes are conducted in the company 6. Floor maps 7. Images of the artifacts associated with the drawbacks in the process 8. Pics of the equipment and materials of the process 9. Pictures related to loading and shipping process 10. Tables for registering observations 11. Tables with standardized measurements

5	Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations	Procedures for a training center on working at heights	1. A flowchart depicting the stages explained by prose 2. Pictures and drawings to analyze and compare the best practices regarding standards for the center and make recommendations for the company 3. Tables for summarizing the result of the evaluations of the situation of the company according to the data collected and analyzed
6	Analysis and proposal of production planning and control systems for a clothing manufacturer	Guidelines for a system of planning and control	1. Diagram of Ishikawa for analyzing company problems 2. Creating flowcharts for production process 3. Creating a flowchart according to the data collected in the company visit 4. Tables with data of materials and processes involved in production process 5. Diagram of Ishikawa for analyzing company problems 6. Tables for summarizing on current situation of the company and improvement proposals 7. Flowcharts of production process of areas of the company

The list of artifacts can be grouped in the following seven categories that summarize occurrences in the sample: a) Diagram/Flowchart (10 cases); b) tables (7 cases); c) artifacts for designing lab guidelines (5 cases) ; d) pictures (4 cases); e) maps (2 cases); f) survey; 1 case); g) video (1 case); and, h) software (1 case) (table 4).

Table 4
Categories of artifacts

Name of the artifact	Types of artifacts mentioned	# of occurrences
Diagram/Flowchart	1. A diagram to depict the stages of loading and shipping processes 2. Content knowledge and its categories are explained by using visual marks to create hierarchies 3. A diagram to identify causes and effects (fishbone) 4. A diagram of Ishikawa for analyzing company problems 5. A diagram of Ishikawa for analyzing company problems 6. A graphic called "problem tree" is used to describe, categorize, rank, and articulate company problems 7. A flowchart depicting the stages explained by prose 8. A flowchart according to the data collected in the company visit 9. A flowchart for production process 10. A flowchart of production process of areas of the company	10
Tables	1. data sheets 2. tables for registering observations 3. tables for summarizing on current situation of the company and improvement proposals 4. tables for summarizing the result of the evaluations of the situation of the company according to the data collected and analyzed 5. tables to summarize and collate data 6. tables with data of materials and processes involved in production process 7. tables with standardized measurements	7

Artifacts for designing lab guidelines	1. Creation of simulated situations and environments of production units to collect and create data 2. Guidelines offer instructions for collecting data and reporting and analyzing the lab experience by writing Guidelines with instructions for students to learn what materials and procedures must be followed to create data 3. Images are used to introduce the lab guidelines 4. the actual lab supplies and materials in the lab of the university lab supplies 5. theoretical frameworks at the beginning of the guideline with citations to contextualize the concept that will be practiced legal documents with standards	5
Pictures	1. pics of the equipment and materials of the process 2. pics of the artifacts associated with the drawbacks in the process 3. pics and drawings to analyze and compare the best practices regarding standards for the center and make recommendations for the company 4. pics related to loading and shipping process	4
Maps	1. A map of the warehouse 2. Floor maps	2
Survey	1. Designing a survey 2. Designing graphics to summarize survey results	2
Video	1. a video is recorded to register how shipping processes are conducted in the company	1
Software	1. a software developed by the Department of planning and production	1

This sorting reveals that “Diagrams” was the most frequent artifact across the sample (10 occurrences). These “diagrams” might be used for depicting company stages on production processes (also referred as “flowcharts”), or organizing information to explain causes and effects of company situations; and, actually, certain types of diagrams are mentioned to do so: diagram of Ishikawa, fishbone diagram, or problem tree. The latter goal can be illustrated with the following graphic of the senior thesis report titled “Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study” in which a fishbone diagram is utilized to depict a company problem related to truck loading and process delay:

Example 7
Title report: "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" (2013)

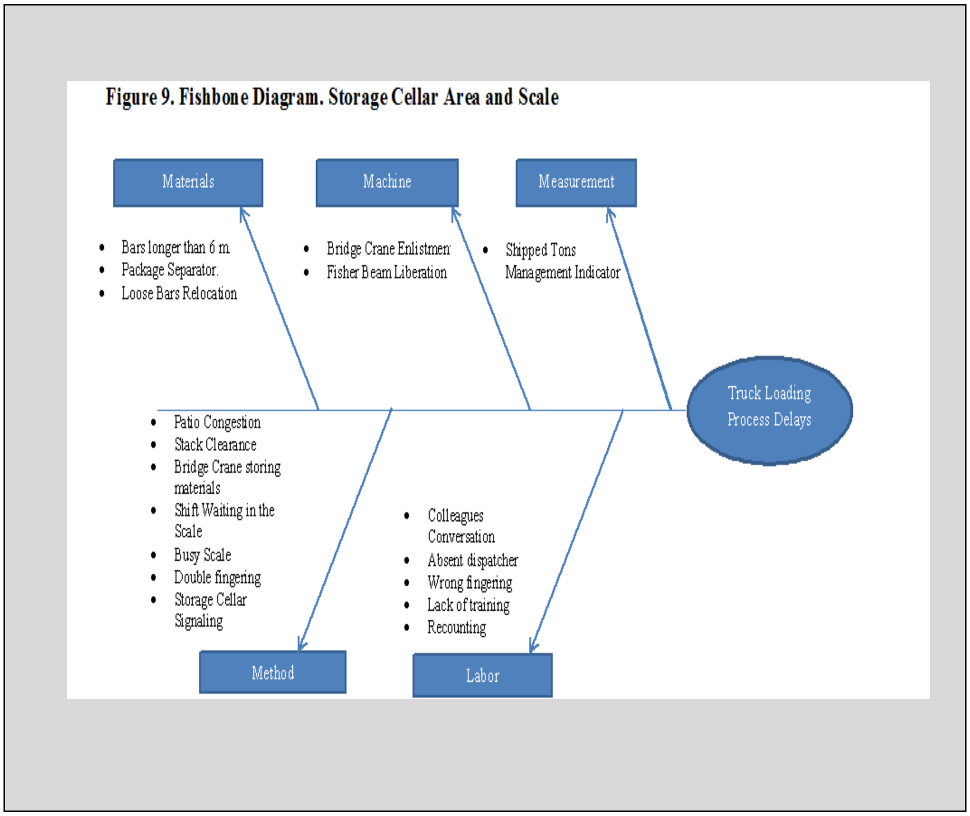


Figure 9. Fishbone Diagram. Storage Cellar Area and Scale

Only in one case, a diagram was used to summarize the theoretical categories used in a senior thesis.

The next more frequent category of artifacts was "tables"; in some cases "tables" were used to register observations (data creation through data sheets/forms) either for lab practices or company analysis (materials, processes, or measurements). The next case is an example of this type of visual identified in the report "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone"; the following tables were developed by the senior student to be filled out by the workers in collecting information to determine the precise amount of packing material that the company needed:

Example 8
Title report: “Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone” (2012)

Table 1. Platform Weight

BOND 60 GR														
	Ream Width (cm)	Ream Length (cm)	Paper Weight	N° Ream Sheets	Ream Weight (kg)	Box – 10 Reams (kg)	N° Boxes/Platform				Weight/Platform (kg)			
							7 Floors	6 Floors	5 Floors	4 Floors	7 Floors	6 Floors	5 Floors	4 Floors
Letter-size Ream														
Legal-size Ream														
Dina4 Ream														

REPROGRAF 75 GR														
	Ream Width (cm)	Ream Length (cm)	Paper Weight	N° Ream Sheets	Ream Weight (kg)	Box – 10 Reams (kg)	N° Boxes/Platform				Weight/Platform (kg)			
							7 Floors	6 Floors	5 Floors	4 Floors	7 Floors	6 Floors	5 Floors	4 Floors
Letter-size Ream														
Legal-size Ream														
Dina4 Ream														

In other cases, "tables" were graphic strategies to summarize by prose descriptions of the evaluations conducted of the company situations by pointing out explicitly drawbacks of the production/selling processes and designing proposals accordingly. For instance, the next fragment of the report titled “Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations” in which the senior student was pointing out company changes to fulfill certification requirements for a training center:

Example 9
Title report: "Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations" (2013)

Table 9. Training Structures

Field	Factor	State
Practical Environment Structures	Scaffolds	Still in certification or purchase process.
	Stairs	Suppliers have been searched and when the center is ready these articles will be sold.
	Pole	
	Façade Work	The structure is not defined yet, it is in design process by the man in charge of the training center of the enterprise.

In two cases, floor maps of warehouses in the companies are included as part of the data analyzed to make measurements and decisions. The following was the case identified in the report titled "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study"; the map is utilized as part of the context for describing the company process under study:

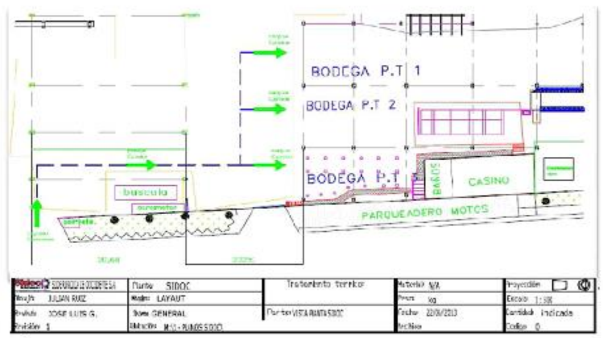
Example 10
Title report: “Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study” (2013)

8. PATH DIAGRAM. STORAGE CELLAR AND SCALE PROCESS

Figure 5. Storage Cellar and Scale Air View.

8 DIAGRAMA DE RECORRIDO PROCESO BODEGA Y BÁSCULA

Figura 5. Vista área de bodega y báscula.



Fuente. Sidoc sa

Source. Sidoc SA

In four cases, pictures are mentioned and used to register “positive” and “negative” practices in companies, as seen below in the report “Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations”. The pictures are used to illustrate “best practices” the company under study must fulfill for a training center certification:

Example 11
Title report: “Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations” (2013)

Figure 31. EPI’S Storage. Training Center II

Figura 31. Almacenamiento de EPI´S centro de entrenamiento II

Fuente: Certificaciones para trabajo seguro en alturas [en línea] Barranquilla: OLX, 2011 [consultado 04 de Mayo de 2013]. Disponible en Internet: http://barranquilla.olx.com.co/certificaciones-para-trabajo-seguro-en-altura-iid-233032984

Source: Certification on safe work at heights [online] Barranquilla: OLX, 2011 [consulted on May 04th 2013]. Available at: http://barranquilla.olx.com.co/certificaciones-para-trabajo-seguro-en-altura-iid-233032984

Only in one case a video is mentioned and a survey that was designed by the senior students; this latter artifact and its subsequent tables and graphics for summarizing quantitative data were part of the report.

For the two samples of senior theses that were related to designing lab guidelines to improve learning processes in the field (Industrial Engineering), the artifacts included: a) images to contextualize the topics of the labs; b) theoretical frameworks to explain categories for the guidelines users; and, c) tables with standards to support data creation during lab practices (see an example in appendix 2).

Software was mentioned only in case # 1 as part of the artifacts related to genre creation: this software was developed by the department of planning and production of a national company spanning foreign commerce in the Andina region.

5. Writing procedures

Table 5 summarizes groups of functions coded as “writing procedures” undertaken by senior students to conduct their senior thesis (i.e., groups of activities led by the senior students in producing the genres or artifacts mentioned including the senior thesis report as an academic genre).

These functions are: a) making a case/defining/justifying a problem; b) creating literature reviews to define categories to be addressed; c) analysis of company situations/production processes; d) creating data; e) summarizing and reporting data; and, g) making evaluations and proposals.

Table 5
Functions of writing procedures led by senior students in producing the genres or artifacts mentioned including the senior thesis report as an academic genre

Writing procedures	Function
• justifying the importance of control on planning production • the senior student defines questions to diagnose the problem • the senior student justifies different benefits of conducting the project for several stakeholders	Making a case
• conducting literature review to document the type of procedures that must be followed • creating a theoretical framework based on international and national literature review on company cases with solutions and types of problems related to loading and truck shipping from warehouse • creating a theoretical framework on safety requirements for working at heights by integrating local and international sources	Creating literature review to define categories to be addressed
• analysis and description of the areas of the company • analysis of methods of planning and control • analyzing a whole process with the collaboration of the workers of the area • analyzing available lab supplies and resources	Analysis of company situation/production process
• auditing lab experiments • calculating times and its cost in product production	Creating data

• collecting data by interviews and representing process stages according to company visits and interviews	
• creating a list of the procedures and methods used in shipping • reporting a narrative in prose of the process conducted • reporting the conclusions of the data collection to make proposals	Summarizing and reporting data
• Analyzing the situation of other companies that are similar to the company that is the locus of analysis • Defining and describing the drawbacks of the company situations to propose improvements	Making evaluations and proposals

For instance, for justifying different benefits of conducting the project for several stakeholders, the following fragment of the report titled "Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*" illustrates a case. This justification mentions positive impacts of this project at three levels, socially, economically, and personally:

Example 12
Title report: "Designing and implementing laboratory practices of ergonomics for the master program on industrial health and safety of *Universidad Autónoma de Occidente*" (2013)

Justification

(…) Socially: this Project development has the purpose of designing laboratory practices and guidelines for the master's degree in Industrial Hygiene and Security, looking for the training of a broader knowledge through experimentation with purpose of offering graduate programs of high level to the community. Also, the proposal of lab practices and guidelines looks for providing students with tools suitable to the enterprises that ultimately will impact the improvement of work conditions, productiveness, and economic growth. Economically: the proposal of lab practices and guidelines will give the students an added value in their training by improving the quality of the academic content provided by the master's degree.

Personally: this project will complement our academic and professional training. Thanks to the research of this subject, the knowledge related to ergonomics of this career will be broadened and it is of great meaning for the integral formation of Industrial Engineering professionals.

Regarding cases of analysis of companies' situations/production processes, the next example illustrates a fragment of the senior thesis titled "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" in which it was necessary to analyze a whole process with the collaboration of the workers of the area:

Example 13
Title report: "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" (2013)

> 12. Time Study
> In order to facilitate the operation measure of the trucks loading, it is necessary to distribute the routine into elements, in other words, every part that composes the routine from the start to the end.
> To make the time study in the steel industry, the operation was analyzed from the truck entry to the scale until its exit. All of this was possible thanks to the collaboration of the storage cellar and scale workers.
>
> Element 1. Scale weighing of the empty truck
> Element 2. Truck parking in the final product storage cellar
> Element 3. Plugs truck enlistment
> Element 4. Bridge crane exit leaving the required packages
> Element 5. Dispatch information registration
> Element 6. Validation
> Element 7.Parking in scale with full truck
> Element 8.Plant exit.

To conduct these types of "analysis of company situations/production processes", the senior students have primarily described i) areas (departments/floors) of the company; ii) production processes; iii) physical environments of the organizations; and, iv) materials and resources available related to the issue addressed in the senior thesis.

For instance in the very same senior thesis report just mentioned "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study", the next fragment shows an example of describing physical environments of the organizations (departments/floors):

Example 14
Title report: "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" (2013)

> 10. Plant Distribution
>
> In Figure 10, the plant distribution is shown and the storage cellar and scale area distribution is presented in Figure 5. From left to right, there is the scale and the bars storage cellars. This distribution was made by the people in charge of the area. (…).

Another example of describing production processes was identified in the following fragment of the report titled "Analysis and proposal of production planning and control systems for a clothing manufacturer" in which is explained how this clothing manufacturer plans and controls its production:

Example 15
Title report: "Analysis and proposal of production planning and control systems for a clothing manufacturer" (2013)

> 7.1.1. Enterprise contextualization
> The fabrication process starts in the Design area that, while it may appear redundant, is in charge of designing the clothing that will be exhibited in each collection. The activity aims to shape a display case for the sales course, which marketing is responsible of, in which the clothing samples are exhibited to advertise the product. Nowadays, Coco Designs works with a low order production system. For this, the marketing labor strength must make the foray in a fast and simple way, putting the orders as the sale cycle goes by. The people in charge of broadcasting the orders to the organization do so by reference, so the order reception is improved and the tailoring orders are scheduled with efficacy, being sure that the produced is the same as the sold. (…)

To undertake these types of descriptions, the analysis of the reports shows that data creation might have involved the following seven practices:

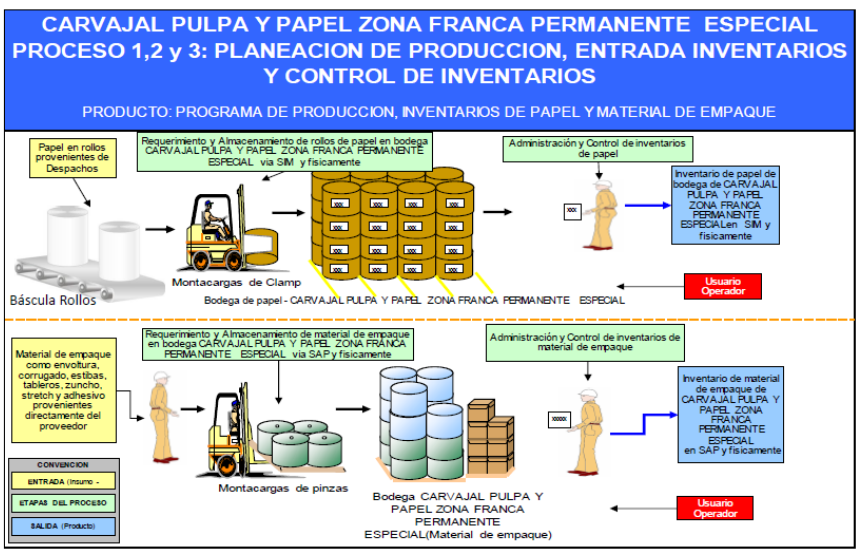
1) Conducting company visits to observe/audit situations; for instance, in the next fragment of the report titled "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone" is mentioned and depicted information about the company process and its benefits,

which might have been explored by visiting and talking with the actual stakeholders of the issue:

Example 16
Title report: "Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone" (2012)

> 9. Carvajal Pulp and Paper Process Description in Special Permanent Free Zone
> (…)
>
> The packaging material such as wraps, adhesives, boxes, pallets, Kraft paper, metal bands, staples, and stretch enter Carvajal Pulp and Paper in Special Permanent Free Zone by the reception and are weighed in the truck scale to know the packaging material weight that is entering in order to make the necessary documentation required by the free trade regime (Figure 4)
>
> The raw material that enters Carvajal Pulp and Paper in Special Permanent Free Zone are products that must have a daily control, otherwise irregularities can emerged and cause the deferral of the fiscal benefits established by the National Government. (…)

Figura 4. Proceso planeación de producción, entrada de inventarios y control de inventarios CARVAJAL PULPA Y PAPEL ZONA FRANCA PERMANENTE ESPECIAL



41

2) Collecting information/needs through interviews from stakeholders (i.e., floor engineers; warehouse managers, floor workers) or perceptions/opinions by defining survey samples and designing/applying survey protocols (e.g., for instructors of labs

and students who took lab practices). The following fragment is an example identified in the report "Analysis of games as teaching tools for teaching and learning on operations management area of the undergraduate program in Industrial Engineering" in which a sample of survey participants is described to explore the impact of games as pedagogic strategy in engineering courses:

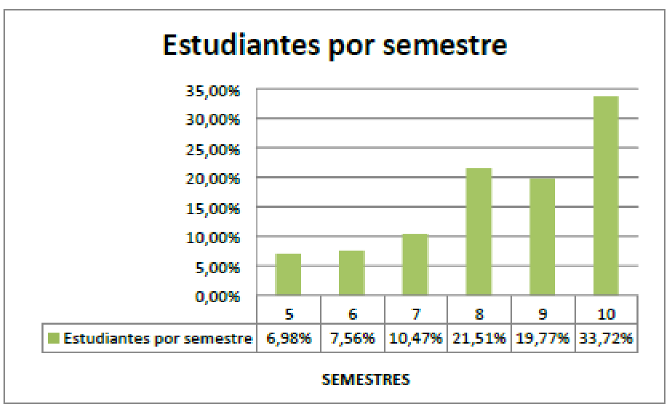
Example 17
Title report: "Analysis of games as teaching tools for teaching and learning on operations management area of the undergraduate program in Industrial Engineering" (2013)

8.1. Quantitative Analysis of the Survey through the Statistic Inference
In this section, an analysis will be shown about the questions of the survey and its comments.

8.1.1. General Information. Semester: The chosen general information was the students' number per semester from 5 to 10, to characterize the semester the majority of the surveyees belong. The results as follows:
From the fifth semester there was total of 6.98% of respondents; form the sixth semester the 7, 56% was surveyed; form the seventh the 10, 47%; in the eighth, the 21, 51%; from the ninth the 19, 77%; and in the tenth semester, there was a total of 33, 72% of surveyed students. This data is shown in the next figure:

Figure 7. Percentage Chart of the Surveyed Students per Semester. (…)

Figura 7. Gráfico de porcentaje de estudiantes encuestados por semestre.



	5	6	7	8	9	10
Estudiantes por semestre	6,98%	7,56%	10,47%	21,51%	19,77%	33,72%

3) Making measurements by calculating performances of old-timers and qualified workers and/or other stakeholders involved who might block the process under study.

A case can be seen in the next fragment of the report “Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study” in which is described how a qualified operator is needed to register time of a regular and effective labor routine:

Example 18
Title report: “Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study” (2013)

> 6.3. Phase 3: Time Definition
>
> To make the time study, it was necessary to select a qualified operator with experience and the needed knowledge to make the routine at a normal pace, in other words, neither speedy nor slow, but a within the pace that could be followed by the majority of the operators during a whole labor routine. With this pace, this worker must register times of every operation process to later design the guidelines based on the regular pace of a daily routine.
>
> A complete description of the used method will be registered by splitting each operation into elements to register the time that the operator invests in each operation element and determine whether the effective pace of the as a standard time in which the operation must be carried out (…)

4) Asking other stakeholders to make measurements associated with the process under study (i.e., floor operators fill out a matrix by a software); for instance, in the senior thesis “Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone”, the next fragment illustrates the role of workers in gathering data for company analysis:

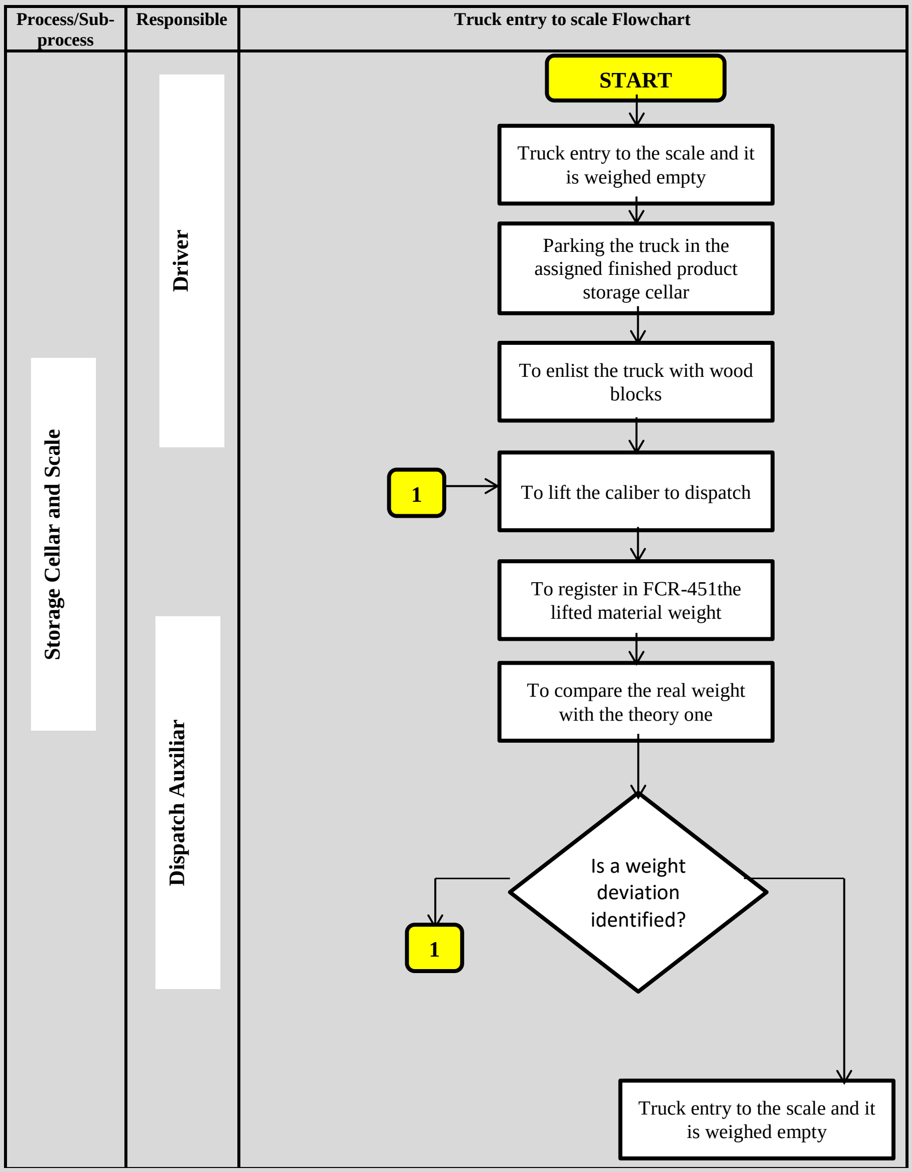
Example 19
Title report: “Balance on materials for legislation of finished product in the company CARVAJAL pulp and paper of permanent special free-trade zone” (2012)

> 13. Packaging material matrix development for the final product legalization
>
> (…)
>
> To create this packaging material matrix that facilitates the final product legalization, it was necessary to make a series of data collection in the production process with the help of the workers to gather all the necessary information useful to consolidate the matrix. (…)

5) Depicting graphically machines, materials, and stakeholders involved in the issue under study, as shown below with an example taken from the report “Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study” in which a flowchart is summarizing the company process that was analyzed:

Example 20
Title report: "Improvement of truck load in the company *Siderúrgica de Occidente* by using a work study" (2013)

Figure 6. Truck entry to scale Flowchart



6) Designing data sheets to collect the types of measurements mentioned in the writing procedure # 3 (i.e., making measurements by calculating performances of old-timers

and qualified workers and/or other stakeholders involved who might block the process under study).

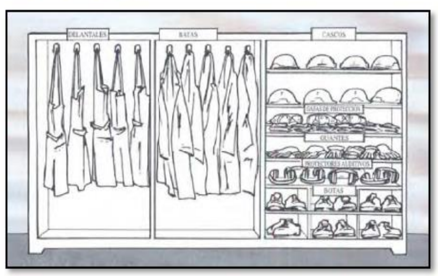
7) Evaluating whether the data collected comply with national and international standards, as can be seen in the following fragment of the senior thesis “Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations” in which the “best practice” required for a certification is described by prose and illustrated by a figure:

Example 21
Title report: “Designing procedures for a certification training center on safe work at heights for the company EPI Ltda. according to current regulations” (2013)

(…) EPI LTDA Enterprise should use a closet as shown in the Figure 32, in which the space assigned for aprons and lab coats could be used for harnesses, slings, and moorings. The closet could be hanged as in the Figure 31 and at the other side, helmets, boatswain's chair, safety net and other equipment demanded by the normativity (…)

Figure 32. EPI’S Closet

Figura 32. Armario de EPI´S



Fuente: ESPAÑA. MINISTERIO DEL TRABAJO Y ASUNTOS SOCIALES. INSTITUTO NACIONAL DE SEGURIDAD E HIGIENE EN EL TRABAJO. Punto de comprobación 106: proporcionar un almacenamiento correcto a los equipos de protección individual. p.2.

Source: SPAIN. WORK AND SOCIAL AFFAIRS MINISTRY. NATIONAL INSTITUTE OF SECURITY AND HYGIENE AT WORK. Verification Point 106: to provide a correct storage to the individual protection equipment.

6. People involved in writing and approving the professional genre mentioned

The exploration of the people involved in writing the genre and people involved in approving the genre suggests that in most of the cases of the sample, the senior student was the most frequent person in charge of producing the genre; furthermore, the analysis of the category: "people involved in approving the genre" was not easily identifiable throughout the sample analyzed (see "non-identifiable" label in table 6).

Table 6
People involved in producing and approving the genres

# sample	Topic/problem addressed in the senior thesis	Genre mentioned	People involved in producing the genre	People involved in approving the genre
1	Standardization of industrial procedures	Matrix	1. Analyst-engineer 2. Floor operators 3. Operations management department	1. Free zone professionals 2. Foreign commerce analysts 3. Managers
2	1. Designing practices and lab worksheets for a class on ergonomy of a master degree on Hygiene and Industrial Security 2. Lab practices that allow students to transfer knowledge to professional settings 3. The project reinforces students' knowledge on ergonomy	Lab guidelines	1. Senior students	Professors and students of the master degree
3	Collecting evidence on the impact of pedagogical games used for junior and senior classes of the area of Operations Management in a major in Industrial Engineering	Lab guidelines for lab practices	1. Senior student	Non-identifiable
4	1. Diminishing freight and shipping in the company to meet customer service quality 2. Designing a plan on loading and unloading routes for containers 3. Workers and truck drivers complain because of delays in loading trucks for shipping company commodities	Creating a guideline for changing procedures	4 people for creating data initially: 1. floor engineer 2. floor manager 3. warehouse supervisor 4. shipping planner	Non-identifiable
5	1. Designing a safety program for working at heights as part a training center in a small company by complying with national standards of accreditation 2. Defining requirements that the company must comply for requesting the accreditation of the safety program training for working at heights 3. Complying with government	Procedures for a training center on working at heights	A senior student making a proposal	Non-identifiable

	requirements (the program and material used in training) on safety programs for working at heights			
6	1. Improvement on planning and control production system of a female clothing manufacturer 2. The company is expanding its market but it is having problems for meeting with shipping time for clients' orders	Guidelines for a system of planning and control	1. Senior student	Non-identifiable

This analysis of the people involved in the types of problems and solutions addressed by the reports that are analyzing on company situations (sample # 1, 4, 5, and 6) confirms that the size of the company/organization is associated with the number of stakeholders involved in the issue. For instance, in the sample # 1, the report is about a senior thesis conducted in a national company producing and commercializing paper and graphic products derived from sugar cane and spanning foreign commerce in the Andina region; therefore, the problem addressed was to standardize industrial procedures by creating a “matrix”. This professional problem implied up to eight stakeholders, namely: 1. engineers; 2. analysts of foreign trade; 3. managers of the same company; 4. operations manager; 5. industrial user; 6. operator user; 7. purchasing department; and, 8. sales executive.

In contrast, sample # 6 was focused on creating guidelines for a system of planning and control in a female clothing manufacturer that designs by client ordering. In this case, the audiences involved in addressing this professional problem were: 1. collaborators/workers; 2. company directives; and, 3. the professional in charge of control and management.

E. Describing academic and professional writing growth in conducting a senior thesis in a Colombian major of Industrial Engineering

By discussing the results previously described according to the literature review of this chapter, this section describes academic and professional writing growth in conducting a senior thesis in industrial engineering.

Rhetorical sophistication for academic and professional writing

The preliminary analysis of six senior thesis reports in a major of Industrial Engineering shows that rhetorical sophistication for students in this major means to deal with writing to make a case by producing a senior thesis as an academic genre. Additionally, this implies producing professional genres and artifacts related to engineering problems either for company situations (sample # 1, 4, 5, and 6) or learning processes in the field (industrial engineering) (sample # 2 and 3).

Aligned with Dressen-Hammouda (2008) claim regarding how disciplinary identities draw on a wide range of semiotic materialities, this study shows that there are non-verbal artifacts that can play a role in both practices: academic and professional writing. For academic writing practices, for instance, content knowledge and its categories are explained by using visual diagrams to create hierarchies, or designing graphics to summarize survey results; and for professional writing practices, for example, there is a case of a diagram to depict the stages of loading and shipping processes, or pictures and drawings to analyze and compare the best practices to fulfill standards of certification for a training center on working at heights.

To describe the type of growth of the students deployed by the senior thesis reports analyzed, the proposal of Dressen-Hammouda (2008) on disciplinary identity progression can be utilized. Within this framework, it seems that undergraduate students in this major tend to address disciplinary concerns with specialist language in their senior theses to offer a narrative of what they have done to address their professors as the main audience. Therefore, that would be the type of academic growth that might be expected in a senior thesis at this level of tertiary education.

Visual artifacts

This analysis contributes in identifying the role of visual or non-verbal practices that have been used by the senior students in accomplishing their senior thesis. “Diagrams” and “tables” are the most common visual artifacts utilized by the senior students. The analysis unfolds that in some cases “diagrams” are means for thinking and making decisions. In other words, in standardizing processes, the novice practitioners seem to have relied on visual strategies/artifacts to describe and analyze company situations (i.e., flowcharts, floor maps), bound problems (i.e., problem tree, pics of “positive” and “negative” practices), and make decisions. These visual artifacts might thus count as strategies to think (writing to think) , since they organize the information collected; however, the analysis does not shed light about to what extent these visual artifacts are utilized to display contents that could be used persuasively with communicating to different stakeholders involved in the issue. Regarding “tables” as visual artifacts, the analysis shows that in some cases “tables” seem to be utilized to summarize drawbacks of company situations/issues addressed in the senior thesis; in these cases, it seems that “tables” might have a rhetorical function in justifying the proposals (innovations/changes) suggested by the senior students. Further studies might be useful in analyzing, when and how students in this major develop a rhetorical awareness of the visual artifacts.

Writing procedures in conducting a senior thesis

The analysis of the "writing procedures" that were undertaken by the senior students in conducting their senior theses confirms that a "senior thesis" is a genre that positions the student between conflicting systems of values related to writing and knowledge production. On the one hand, the senior students have carried out academic writing and knowledge production such as "making a case" (i.e., justifying their projects for the faculty of the major) or "creating literature reviews" (i.e., searching and writing about international and national cases for bounding theoretical frameworks to analyze their own cases). In these instances, data creation might be associated with research data collection such as those carrying out in social sciences: conducting company visits to observe/audit situations, and collecting information/needs through interviews from stakeholders or perceptions/opinions by surveys. On the other hand, the senior students have created data as practitioners of the field; this means that further in their careers the following activities are possibly part of their professional practices: a) making measurements by calculating performances of old-timers and qualified workers and/or other stakeholders involved who might block the process under study; b) asking other stakeholders to make measurements associated with the process under study (i.e., floor operators fill out a matrix by a software); c) depicting in maps elements such as machines, materials, and stakeholders involved in the issue under study; d) designing data sheets to collect the types of measurements mentioned in b), and e) evaluating whether the data collected comply with national and international standards.

The contradictions emerge for senior students in defining whether the latter (creating, summarizing, and reporting data created as part of professional performances) counts as strategies to address rhetorically their faculty and/or other stakeholders involved in the issues related to their senior theses. The risk of not supporting engineers in gaining awareness of rhetorical differences between these two writing and knowledge practices is that the conflict might be solved by reducing writing to summarizing by telling chronologically or putting together events that basically count as accountability reports (Winsor, 1996).

Professional genre knowledge, genre production, and disciplinary identity within local contexts

As Spinuzzi (2010) claims, the professional practices identified in this analysis to produce and create professional genres and artifacts seem to be part of routines and cycles. This might be related to the most frequent professional genre identified: “guidelines”. According to the analysis, the senior students in this major are expected to create data for describing routines and cycles of company situations, which includes non-verbal writing for visual and spatial reasoning to evaluate current situations/processes and then make proposals to redesign new routines and cycles that will be mediated by documents as tables, graphics, matrix, and guidelines of procedures.

Consequently, this analysis suggests that one of the professional genre knowledge that seems to be related to industrial engineering is the development of guidelines, which are created through collecting data from other stakeholders involved in the issue and by complying with national and international standards related to company/institution situations.

As for how these engineering students might have produced their data, the studies of Winsor (1996 & 2003) point out that engineers regard data as authoritative and fixed, since it is created by computational machines. Unlike Winsor' studies, this analysis shows that these senior students created data by the following means not by utilizing machines: a) designing visual artifacts (tables and forms) and involving other stakeholders in filling out them, especially workers and machine operators; and, b) interviewing owners, plant managers, and head of sales; later, the senior students summarized such data collection by creating diagrams done by them not by machines.

However, as Winsor (2003) suggests, data creation might be also regarded as authoritative, since there is no evidence in the sample of further evaluation or revision of the artifacts and professional genres created to mediate process and practices in the organizations. This might suggest that there is not an assumption that genres and artifacts associated with its creation are live semiotic materials embedded in ongoing human practices and thus required be updated and assessed according to actual usage and circulation among stakeholders (genre users). This study cannot confirm whether this lack of social awareness in genre usage was a particular issue associated with conducting a senior thesis (i.e., the scope of the projects in the major is at least to create artifacts and genres to modify current company/organization situations), or whether it is a broader assumption associated with the field in general or with this major in particular.

The analysis of the reports also confirms that the disciplinary/professional identity enacted by the senior students is primarily associated with solving problems in companies and standardizing procedures. Therefore, this study ratifies that engineers address professional activities as part of "distributed cognition", which means that engineers act in concert to accomplish a goal that, otherwise, it is not achievable or is not possible to attain individually (Winsor, 2003). Additionally, the analysis of the number of stakeholders involved in the types of problems addressed by the students in conducting their senior theses suggests that the main role of these senior students as novice practitioners within the organizations was to problematize company procedures by evaluating current situations, and propose improvement projects accordingly.

However, the analysis of the reports also reveals that in problematizing and solving situations, the senior students were interacting with other stakeholders basically for collecting data (e.g., floor engineers; warehouse managers, floor workers) rather than for negotiating and justifying the creation and implementation of new procedures and, in turn, new genres attached to such innovations. Therefore, in terms of professional growth, the analysis of the reports confirms, as Artemeva (2009) claims, that senior students in this major were able to utilize cultural capital and domain content expertise in industrial engineering to conduct their senior thesis, particularly that they were enacting genres and practices of their communities of practices (i.e., creating data based on standards, and designing tables, forms, guidelines with procedures, and a matrix to improve profits in organizations and comply with regulations).

Although the senior students as novice practitioners seemed not to have been actual "members" of the companies/organizations in which their senior theses were conducted, they created genres such as "guidelines" as "a writing product" that is embracing the goal of standardization. It is interesting to mention that the type of reality that seems to be a professional end in this field, Industrial Engineering, and perhaps also in the major, is to writing for normalization and regulation. To accomplish this goal, the analysis of the "writing procedures" suggests that the senior students of this major are mainly creating data against national and international standards, which suggests that their professional performance is basically accepting what has been defined and implemented in local contexts without critical stances.

This tendency as a way of doing and thinking in this major might undermine the development of rhetorical awareness in their practitioners and be also a feature of the ideology maintained and reproduced in the program. This writing ideology (i.e., writing to normalize and regulate) might be problematic taking in consideration that studies on engineering environments have confirmed the rhetorical nature of interactions among several stakeholders in companies (Winsor, 1996 & 2003); however, it is also interesting to notice that the size of the companies/organizations that were the context of the reports analyzed is related to the number of the stakeholders involved in the issue and the degree of complexity of the communication practices to negotiate solutions and circulate, create, and accept genres[41]. This means that the data analyzed suggest that senior students in this major would have opportunities to develop rhetorical abilities to persuade different stakeholders by designing and creating genres and its artifacts according to the size of the companies.

In other words, it seems that a local developing economy shapes the types of companies and, in turn, the learning opportunities from which the senior students might develop their experiences as professionals and, likely, as future company members.

[41] Only in one case, software was mentioned as part of the artifacts involved in the issue under study and it was related to a senior thesis conducted in the larger company of the sample, which it is an organization exporting its products to the Andina region.

Furthermore, it is interesting to notice that having a critical stance upon the international standards might be a challenging position to take for these senior students under the assumption that such regularization is mandated by developed economies; thus, it is not under negotiation. Therefore, it is not worth for senior students to discuss on the issue, which might reinforce the authoritative value of "data" of engineering contents and genres (Winsor, 1996).

F. Conclusion

The analysis confirms that writing a senior thesis report is complex and demanding since both academic and professional writing growth are expected from the students; for instance, academic practices such as making a case by justifying the importance of the senior theses and creating literature reviews to define categories to be addressed; but also, professional practices such as creating data by designing forms to be filled out by operators, observing and registering company procedures, or comparing company practices against national and international standards. One of the most frequent ways of doing and thinking inferred by the reports was to "standardizing procedures" either for company situations or teaching practices in the field, and there might be a relationship between this professional practice and the most frequent "genre" mentioned in the sample: "guidelines".

In terms of the role of visuals, "diagrams" and "tables" are the most common visual artifacts utilized by the senior students. The analysis unfolds that in some cases these visual artifacts count as strategies to think (writing to think), but not necessarily to display information that could be used persuasively in communicating with different stakeholders involved in the issue.

Regarding expectations of rhetorical sophistication, this analysis confirms that senior undergraduate students were able to address disciplinary concerns with specialist language in their senior theses to offer a narrative of what they have done to address their professors as the main audience. However, the analysis did not explore the qualities of these types of academic narratives, since the senior thesis reports offer no contents to explore professional writing growth related to the ability of reporting senior thesis activities to other than faculty members, such as owners, managers, plant managers, head of sales, workers, and/or operators in the company/organizations.

The analysis of these reports also suggests that data creation might be regarded as authoritative, since there is no evidence in the sample of further evaluation or revision of the artifacts and professional genres created to mediate processes and practices in the organizations. This study cannot respond whether this lack of social awareness in genre usage was a particular issue associated with conducting a senior thesis in this program (i.e., the scope of the projects is at least to create artifacts and genres to modify current situations in companies/organizations), or whether it is a broader assumption associated with the field in general, or with this major in particular.

The number of stakeholders involved in the types of problems addressed by the students in conducting their senior theses suggests that the senior students as novice practitioners seemed not to have been actual “members” of the companies, but they created genres such as “guidelines” as “a writing product” embracing the goal of standardization. Writing for normalization and regulation might be a learning expectation for this Colombian major in Industrial Engineering.

One of the hypothesis emerging from this study is that the size and ideological localization of the companies that were the context of the reports analyzed (i.e., small local business of a developing economy in the South that are striving to comply with international and national standards), might impact a) the degree of complexity of the communication practices to negotiate solutions and circulate, create, and accept genres (small companies, few stakeholders involved, less negotiation to create and accept genres, which might generate more vertical and hierarchical communication), and b) the opportunity for engineering students to develop critical stances about improving entrepreneurial environments, since they might be more concerned in genre consumption and production (such as regulations and guidelines) to regulate practices under external powerful standards (which might be primarily mandated by developed economies). Therefore, it might be interesting to conduct further comparative studies on exploring genre productions and consumptions of "guidelines" in educating industrial engineers of developed and developing economies.

G. Implications

This analysis suggests that an engineering program aiming at preparing students for participating of globalized economies should incorporate curriculum opportunities for: a) analyzing different complexities of communication practices and interactions of entrepreneurial environments; as well as, b) learning projects to conduct critical analysis of the current international and national standards in contrast to local situations and needs. This pedagogical program might educate engineers by highlighting the importance of individual agency emerging from the stakeholders in workplaces when they enact daily practices of "standardizing genres" and "standardized genres". Therefore, further analysis of the current learning initiatives in the major context of this chapter might be also beneficial for exploring pedagogical experiences that allow students to gain awareness on the critical role of texts in maintaining and creating "powerful positions" for accumulation and appropriation of capital within organizations (Winsor, 2003).

It might be also important to conduct further studies on when and how the students of this major learn how and why to design and create "guidelines" as professional genres that might be needed in the environments they will be part of. The tendency identified on creating "guidelines" might be tied to the need of small business in a developing economy complying with international standards to be accepted as part of global business and economy; therefore, further studies might be conducted to explore if the genre "guidelines" would be also a frequent genre in educating industrial engineers of developed economies.

Ultimately, this study claims that conducting and writing a senior thesis in this major may become a writing endeavor comprised of two different writing practices that account for academic and professional growth of students while they address different audiences. In other words, a senior thesis in this field and major might include: a) one report addressing faculty members by reporting academic writing practices associated with data creation and analysis (this report should include traditional sections of academic projects such as introduction, problem statements justification, literature review, theoretical frameworks, methodology, results, analysis, and conclusions); and, b) another report comprised of small reports to be presented ideally in meetings to owners, managers, plant managers, head of sales, workers, and/or operators in the company/organizations. The idea is not to keep presenting artifacts related to professional genre production (such as tables and forms) or the actual professional genres (guidelines and matrix) created by the senior students as appendices of the senior thesis. Instead, the goal might be to make visible these two types of genre and knowledge production.

Implementing this distinction between creating and reporting knowledge might be useful, on the one hand, in helping students to deal with differentiating academic writing practices from professional writing practices while they have opportunities to increase their audience awareness by creating reports that address persuasively readers other than their own professors, and, on the other hand, in allowing faculty members of the major to assess different paths of writing development: academic writing practices to accomplish a senior thesis, and professional writing practices to participate as novice engineers in companies/organizations.

Appendix 1
List of ways of doing and thinking[42]

List created in the prior study based on syllabi	
Ways of doing (i.e., methodologies to become a practitioner or learn a discipline)	**Ways of thinking (i.e., systems of values/ideologies of a discipline/profession including types of reasoning for conducting cognitive procedures such as comparing, criticizing, making claims, and drawing conclusions)**
• Making claims to analyze case studies based on theoretical frameworks of the class (CSTF) • Making decisions to design solutions based on procedures learned in the class (MDDS) • Making decisions to design and redesign to improve productivity and profitability (MDPP) • Multivariable thinking to make decisions (MVT) • Evaluating others' written productions (EOWP) • Negotiating reading meanings by discussing with others (PVAO) • Addressing writing as a process (WP) • Writing implies prior reading and intertextuality (WPRI) • Reading carefully bibliographic resources (RCBR) • Making measurements and creating data (CD) • Developing and implementing control and management strategies (CMS) • Working collaboratively (WC) • Preparing and delivering oral and written presentations (PDOWP) • Including graphics in presentations (GP) • Standardizing procedures (SP) • Training other workers (TW) • Making decisions to design and redesign on human resources based on expectations of companies (MDHR) • Information management (IM) • Solving problems methodically (SPM) • Selecting materials and procedures efficiently based on budgets (MPB) • Writing Standards and guidelines manuals (WSM) • Mastering an engineering protocol for projects (MEP) • Selecting bibliography (SB) • Writing cohesively (WCY) • Raising resources and funding (RRF) • Depicting graphically and holistically companies (DGHC) • Writing a senior thesis proposal (WSTP) • Mastering a standard citation format	• Making decisions to design and redesign to improve productivity and profitability (MDPP) • Multivariable thinking to make decisions (MVT) • Expressing a personal voice respectfully among others vantage points (PVAO) • Evaluating others' written productions (EOWP) • Negotiating reading meanings by discussing with others (PVAO) • Addressing writing as a process (WP) • Writing implies prior reading and intertextuality (WPRI) • Reading carefully bibliographic resources (RCBR) • Developing and implementing control and management strategies (CMS) • Working collaboratively (WC) • Standardizing procedures (SP) • Making decisions to design and redesign on human resources based on expectations of companies (MDHR) • Information management (IM) • Solving problems methodically (SPM) • Identifying differences between Engineering as a field and the student major (ESM) • Bounding and defining engineering problems (EP) • Selecting materials and procedures efficiently based on budgets (MPB) • Anticipating social, environmental, economic, and legal limitations of a project to propose mitigations (LM) • Depicting graphically and holistically companies (DGHC) • Developing systemic thought (ST) • Mastering a standard citation format [ICONTEC] (SFC) • Writing as senior thesis as a process bounded by timelines, deadlines and budgets (WPTDB) • Understanding the interplay between conventions, mechanics and intended audiences (CMA)

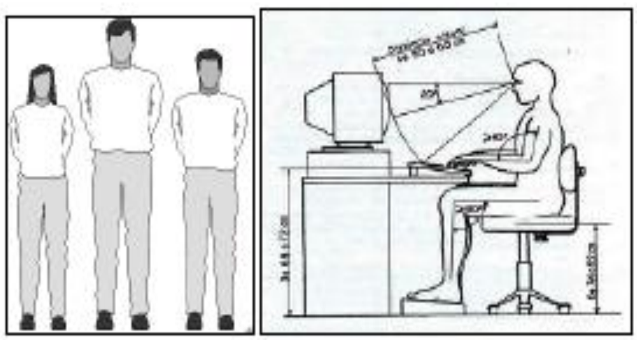
[42] Some of the categories appear in both columns, as ways of doing and thinking, since they seem to involve these two types of reasoning.

[ICONTEC] (SFC) • Mastering genre conventions of a senior thesis for the institution (STI) • Understanding the interplay between conventions, mechanics and intended audiences (CMA) • Writing as senior thesis as a process bounded by timelines, deadlines and budgets (WPTDB)	
Emerging categories from the analysis of senior thesis reports	
Ways of doing (i.e., methodologies to solve problems as practitioners of the field)	**Ways of thinking (i.e. systems of values/ideologies deployed by senior students through the reports)**
• Analyzing company situations and procedures under legal standards (CSLS) • Comparing business processes and performance against industry best practices from other companies (BM) • Making measurements according to norms and standards (MMN) • Calculating times and its costs in a production process (CTC) • Making decisions to design and redesign to improve productivity and profitability for companies and other stakeholders by synchronizing all departments in companies(MDPP) • Creating measurements to track over time production process and make decisions based on productivity and profitability • Developing and implementing production plans based on productivity and profitability. • Designing forms for describing and evaluating employees' performances—for describing and defining standards of production. • Defining and describing employees' duties • Writing to design pedagogical artifacts for lab practices	• Analyzing company situations and procedures under legal standards (CSLS) • Making claims to analyze case studies based on theoretical frameworks of the senior thesis (CSTS) • Comparing business processes and performance against industry best practices from other companies (BM) • Making measurements according to norms and standards (MMN) • Calculating times and its costs in a production process (CTC) • Making decisions to design and redesign to improve productivity and profitability for companies and other stakeholders by synchronizing all departments in companies(MDPP) • Creating measurements to track over time production process and make decisions based on productivity and profitability • Developing and implementing production plans based on productivity and profitability.

Appendix 2
Fragment of lab guidelines

GUIADELABORATORIO

RELACIONES CORPORALES ANTROPOMETRIA



1.OBJETIVOS

- Identificar y medir las características antropométricas de un grupo de individuos en posiciones antropométricas de pie y sentado.

- Realizar mediciones antropométricas en los puestos de trabajo utilizando el concepto de antropometría dinámica.

- Aplicar correctamente los procedimientos y normas para tomar dimensiones corporales de las personas.

- Calcular los valores medios, la desviación estándar y los percentiles de cada característica antropométrica considerada.

- Evaluar la información respecto a los estudios e investigaciones existentes el comportamiento de las mediciones realizadas.

2.MARCO TEORICO

Antropometría es la disciplina que describe las diferencias cuantitativas de las medidas del cuerpo humano, estudia las dimensiones tomando como referencia distintas estructuras anatómicas, y sirve como herramienta a la ergonomía como objeto de adaptar el entorno a las personas.[39]

Existe mucha información antropométrica contenida en cuadros y estudios de determinados grupos de poblaciones, esta información examinándola con el cuidado necesario y advirtiendo todas sus posibles diferencias respecto a nuestras necesidades, sirven de gran ayuda en diseño de asientos y determinados puestos de trabajo. En tal sentido podrán servir de ayuda un amplio número de recomendaciones hechas en materiales y literaturas orientadas en clases. Las dimensiones estructurales del cuerpo se toman con el cuerpo de los sujetos en posiciones fijas (estáticas) estandarizadas, donde se miden las diferencias estructurales del cuerpo humano en diferentes posiciones y sin movimiento (en reposo).[40]

Cuando se diseña para un grupo poco numeroso y para una población numerosa hay que tener en cuenta tres principios de diseño antropométrico:

- **Principio del diseño para hombres extremos:** El diseño se concibe a partir de referentes de compromiso por cada una de las dimensiones corporales relevantes para el diseño.
- **Principio del diseño para intervalos ajustables:** Diseño flexible y adaptable a una población numerosa.
- **Principio del diseño para hombres promedios:** Decisiones de escasa aplicación que se adopta cuando la dimensión tiene poca significancia en el diseño o tenga una utilización infrecuente.

Los percentiles son aquellos valores que dividen la muestra ordenada de datos antropométricos en 100 partes iguales p1, p2... p100. De forma intuitiva podemos decir que es un valor tal que supera un determinado porcentaje de los miembros de la población.[41]

Existen diferentes métodos para hallar los percentiles uno de los más comunes es la normalización de los datos agrupados a partir de la siguiente ecuación:

$X = Z * S \pm \bar{X}$(Ecuación 1)

$\bar{x} = \frac{\sum_{i=1}^{n} x_i n_i}{N}$ (Ecuación 2)

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[39]RamírezCavasaCesar.ErgonomíayProductividad.NoriegaEditores.México1991.P.53
[40]RamírezCavasaCesar.ErgonomíayProductividad.NoriegaEditores.México1991.P.53
[41]ÁlvarezLlanezaFranciscoJ.Ergonomíaypsicosociologíaaplicada:Manualparalaformacióndelespecialista.EditorialLexNova,2007.P.164

X: Valor que representa el percentil.

$\bar{X}$: El promedio de los datos (media)

S: Desviación estándar de la muestra.

Z: Factor de correlación.

A partir del siguiente cuadro se puede encontrar el valor de Z para los diferentes Percentiles deseados:

Cuadro 1. Valores de Z

PERCENTIL	VALOR DE Z
99.5	2.576
99	2.326
97.5	1.960
95	1.645
90	1.285
85	1.036
80	0.842
75	0.674
70	0.524
50	0.0
30	-0.524
25	-0.674
20	-0.842
15	-1.036
10	-1.285
5	-1.645
2.5	-1.960
1	-2.326
0.5	-2.576

Fuente: Creado para esta obra

LABORATORY GUIDE

BODY RELATIONS ANTHROPOMETRY

1. OBJECTIVES

- To identify and measure the anthropometric characteristics of a group of people in anthropometric positions, seating and standing.

- To do anthropometric measures in work places, using the dynamic anthropometry concept.

- To correctly apply the procedures and norms to take people's body dimensions.

- To calculate the mean values, the standard deviation and the percentiles of each considered anthropometric characteristic.

- To evaluate the information regarding the studies and existent investigations about the measures behavior.

2. THEORETICAL FRAMEWORK

Anthropometry is the discipline that describes the quantitative differences of the human body measurements. It studies the dimensions parting from anatomic structures and works as a tool for ergonomics as an object to adapt the environment to people.39

There is a lot of anthropometric information comprised in charts and determined groups studies. If this information is rigorously examined taking into account the possible differences in relation to our needs, it can be very helpful in chairs and some work places design. In this sense, a broad number of recommendations built in class materials and literatures would be very helpful. The body structural dimensions are taken with the individuals' bodies in standardized fixed positions (static), where the structural differences of the human body in different positions and in fixed positions are measured.[40]

When the design is made for a small group and for a big population, three anthropometric design principles are to be considered:

- Design for Extreme Men Principle: This design is conceived from commitment referents for each one of the relevant body dimensions.

- Adjustable Intervals Design Principle: Flexible design and adaptable to a big population.

- Average Men Design Principle: Decision of little application adopted when the dimension is not significant in the design or has little use.

[39] RamírezCavasaCesar.ErgonomíayProductiidad.NoriegaEditores.México1991.P.53
[40] RamírezCavasaCesar.ErgonomíayProductiidad.NoriegaEditores.México1991.P.53

The percentiles are values that divide the organized sample of anthropometric data by 100 equal parts p1, p2…p100. In an intuitive way, it is possible to say that it is a value that overcomes a determined percentage of the population. [41]

There are different methods to find percentiles. One of the most common is the normalization of the gathered data, through the next equation:

X: Value representing the percentile.

X: The data average (mean)

S: Standard Sample Deviation

Z: Correlation Factor

In the next chart the Z value is assigned to the different desired percentiles:

Chart 1. Z Values

PERCENTILE	Z VALUE
99.5	2.576
99	2.326
97.5	1.960
95	1.645
90	1.285
85	1.036
80	0.842
75	0.674
70	0.524
50	0.0
30	-0.524
25	-0.674
20	-0.842
15	-1.036
10	-1.285
5	-1.645
2.5	-1.960
1	-2.326
0.5	-2.576

Source: Created by this Work.

41ÁlvarezLlanezaFranciscoJ.Ergonomíaypsicosociologíaaplicada:Manualparalaformacióndelespecialista.EditorialLexNova, 2007.P.164.

V. Chapter 5. Writing experiences of Colombian engineering students: writing variation within a major in Industrial Engineering

Abstract

Since 2009 an exit large-scale assessment has been applied in Colombia to evaluate undergraduate writing development. Latin-American studies on writing development are scarce and limited to questions about freshman composition courses or writing to learn regardless the disciplines. Furthermore, current public policies in Colombia for the advancement of science, technology, and innovation are funding PhD education for engineers overseas; thus, this field is an important research site to spur debates about disciplinary writing development and variation. A prior analysis of syllabi since freshman to senior classes of a Colombian major in Industrial Engineering suggests that there is no overt pattern across semesters regarding specific growth or changes across time for different types of writing and communication practices to learn and become practitioner of the field. Therefore, this chapter creates accounts of writing variation by curriculum years in Industrial Engineering from the students' perspectives by exploring retrospective accounts of writing experiences and analyzing writing assignments. Although the analysis of voices/discursive identities of writing assignments reveals multifaceted roles that must be enacted by students as writers (professional in innovation, company analyst, or lab researcher), there is no evidence to claim that these experiences demanded students' participation within communities of practice. The findings overall suggest that students of this major are not developing genre awareness (ability to identify and report genre features), although they seem to be able to produce/mimic texts of diverse genres.

A. Introduction

As part of the accreditation agendas, The Colombian Institute for the Progress of Higher Education (*ICFES*) has mandated since 2009 an exit large-scale assessment for senior undergraduate students. This assessment is comprised of 34 tests evaluating different disciplinary/professional knowledge. A common section assesses writing in Spanish, quantitative skills, problem solving, interpersonal understanding, and reading in Spanish and English. This common section assumes that writing, as the other general competencies, undergoes development during college regardless disciplinary/professional growth.

A preliminary exploration of research topics in recent Latin American publications (2008-2012) reported by survey participants in a study titled "Writing initiatives in higher education, ILEES Latin America" (see http://english.ilees.org/)[43] suggests that studies on writing development are scarce. 14% of publications reported are focused on students' changes as writers, and those are limited to questions about the impact of freshman composition courses (Flórez et al., 2010, 2011) or learning changes associated with systematic interventions for learning disciplinary concepts through writing (López & Ramírez, 2012; Arciniegas & Lopez, 2012). This does not tell us about how students' disciplinary writing develops in more advanced courses and in specific disciplines.

Current public policies in Colombia for the advancement of science, technology, and innovation are funding PhD education for engineers overseas as part of a commitment to national progress. Therefore, engineering is an important research site to spur larger debates about disciplinary writing development and variation.

The analysis of 22 publications on Latin-American writing initiatives and studies in engineering reveals emerging endeavors (since 2009) that are focused on engineering as one field, and primarily advocating for writing to learn and less for other scientific and professional practices. Furthermore, the analysis of 18 syllabi from freshman to senior classes of a Colombian major in Industrial Engineering reveals writing variation to learn and become practitioner of the field[44]. However, this analysis also suggests that there is no overt pattern across semesters regarding specific growth or changes across time for different types of writing and communication practices.

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[43] This project collected information between 2012 and 2013 through invitations and voluntary participation in an online survey that was applied to scholars from Argentina, Brazil, Chile, Colombia, Mexico, Puerto Rico, and Venezuela.

Therefore, this chapter describes development of writing variation within a Colombian major in Industrial Engineering by creating accounts of writing variation across curriculum years through exploring students' retrospective accounts of writing experiences and analyzing writing assignments.

B. Conceptualizing writing development in college years and in engineering

The following literature review first describes research implications and conceptualizations on writing development in college; this overview informed the designing of a qualitative survey to collect retrospective accounts of writing experiences. This section also offers an overview of specific features of disciplinary and professional writing and communication in engineering, which informed particularly the analysis of the writing samples.

1. Conceptualizing writing development in college

Since there is an interplay between expertise and development, the following features of expert performance are used to describe development: a) ability to organize information to support further recall (usable knowledge); b) ability to configure problems mentally to solve them by making connections among diverse kinds of information; c) ability to identify conditions of applicability of usable knowledge (relevant knowledge); d) ability to monitor and regulate processing and change strategies as necessary; and, e) ability to perform practices in specific contexts that are bounded by knowledge domains (Bransford, John, et al., 2000).

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[44] For instance, by bounding engineering problems in companies and proposing solutions by writing case-study reports; writing standards, guidelines, and manuals to improve processes and profits in organizations; or, mastering an engineering protocol for research and innovative projects.

Accordingly, researching about writing development as achieving expertise requires a methodological approach for examining how people deal with writing situations seen as a problem and, the amount and types of resources involved in solving it (writing as problem-solving situation). This problem-solving perspective claims that providing real audiences for students improves writing performance. Experiments conducted with think-aloud protocols of actual readers (usability testing) confirm that readers' evaluation increases audience awareness of students/writers (Rijlaarsdam, et al., 2009).

Furthermore, studies at the end of high school and college years have acknowledged that students achieve different levels of writing maturity shaped by home writing experiences and other cultural participation (writing sponsors or other writing experiences besides schooling learning, and even through different languages). Therefore, trajectories on writing development will vary because of the features of personal trajectories (Beaufort, 1999; Carroll, 2002). According to Carroll (2002), students thus may be fluent in some circumstances and not in others. Findings from her study have shown that development over time and across college years means to write differently, mainly because students have learned how to satisfy writing demands across contexts that might be even contradictory. Consequently, students over time do not display improved writing performances for specific types of writing, rather they acquire extended differentiated conceptions of diverse writing experiences. This study also confirms that students perceived that they have learned (change or develop) as writers during transitional experiences, particularly when individual circumstances (private motives) and curriculum opportunities (i.e., international exchanges or internships) -as social exigencies- overlap to boost changes (Carroll, 2002). As a result, what students seem to develop is a "rhetorical survival instinct" in order to deal with diverse academic writing tasks (Brent, 2012). What is problematic with such rhetorical survival is that students seem to guess what is expected, because “good writing” is something that they must figure out by themselves across courses and college years (Beaufort, 2007).

These studies have therefore confirmed that variation is the expected condition for composing and composers (Blake, 2015): variation among students’ composing processes, their histories (literacy trajectories), and identities; thus, teaching on writing from a developmental perspective is regarded as a complex and sophisticated task (Blake, 2015).

Since written products of students do not in themselves unfold the whole story of writing development, additional kinds of data must be gathered through mixed methods (surveys, interviews, class observations, and textual analysis) (Carroll, 2002; Beaufort, 2007).

Notions of “development” also shape the studies. For instance, to explore writing development as an individual achievement, “rhetorical skills” and “rhetorical competence” are differentiated. The “rhetorical skill” is described as an ability manifested in the actual production of writing; whereas, “rhetorical knowledge” is the competence, which is the knowledge to encompass the sum of what the writer is in principle capable of doing, based on internalized knowledge, whether or not that competence is performed in each and every act of writing (Brent, 2012).

The unit of writing analysis also impacts developmental research. To research about writing development, the analysts must include students’ perceptions about the task, particularly how students have made sense of learning situations. Paying attention carefully to students’ perceptions about environments in which they write provides information regarding writing development contexts (Carroll, 2002). This type of data provides insights about genre learning either by retrospective accounts or naturalistic observation. Accordingly, creating data about genre learning includes collecting and analyzing information on students’ writing and reading experiences, teacher’s writing assignments, and students’ talk about writing. The main goal is to understand how students' make sense of genre (i.e., sense of shape, structure, rhetorical stance, and thinking strategies) (Reiff & Bawarshi, 2011). Furthermore, genre learning encompasses genres awareness, but this knowledge is not sufficient to produce a text (genre performance). Students' awareness of genre, which is their ability to identify and report genre features, does not necessarily enable them to produce a text in a given genre (Artemeva, 2010).

This overview shows the field on Writing Studies is still debating the methodological approaches to render more complex accounts about writing development not only to complicate institutional expectations of getting homogeneous writing expertise for all of the students, but also to describe comprehensively what happens across time with students as an interactive phenomenon in which instructional contexts, other institutional learning opportunities, and personal literacy trajectories are intertwined.

In order to do so, theoretically speaking, development is also seen as increasing participation in communities of practice. Within this perspective, development is achieved, as a result of immersion, when novices learn by doing and working alone or with others as an evolving form of membership within a community that shares a profession; being a participant of a community of practice is a fundamental condition for learning, since observing is not enough to learn. This phenomenon is called "legitimate peripheral participation" (apprenticeship experiences) and explains that newcomers are allowed to make some errors while observe, imitate, and achieve small tasks until they are able to face more difficult tasks and develop a sense of identity within a community of practice; thus, social relationships of apprentices change over time while they participate in community activities (Lave & Wenger, 1991). This participation also brings implications for identity formation, because collective and individual meanings are produced, reproduced, and changed in the course of a community activity; as a result, people are always in progress while they are gaining membership positions in a community of practice (Lave & Wenger, 1991).

Within this sociocultural approach, the role of artifacts (cultural tools such as language) is central in accessing the social practices of the communities. Since newcomers access to the community through different social interactions, the degree to which old-timers are willing or not to offer scaffold and support to novices might promote or prevent accessing and learning communities' practices. This means that authority of masters and variety of resources can vary dramatically across apprenticeship experiences. Social interactions between old-timers and newcomers are, thus, essential keys in learning language and communication to become a member of a community of practice; this is, learning how to "talk" as a fully member of the group by talking within the community and addressing their members. Consequently, the very act of learning how to participate can be facilitated or blocked by power and hierarchical structures that are displayed through language and communication practices (Lave & Wenger, 1991).

This sociocultural perspective of development has been important to boost the debate about the differences between writing learning experiences in academia and workplace settings (Dias & Paré, 2000). Genres that are elicited in academia and workplaces embrace diverse human activities, since they imply different types of language (including diverse semiotic materialities), meanings, and types of interactions to respond to different purposes (Dias & Paré, 2000). This sociocultural perspective has conceptualized learning differences in both places (academia and workplaces) by characterizing the notions of "guided participation" (or cognitive apprenticeship) and "facilitated performance" (learning by explicit scaffolding). In both categories, learning ensues through performance and engagement, the process is social, based on interactions and the use of tools or other cultural artifacts as language. However, the difference is that learning is an explicit goal in “guided participation” whereas learning is accidental in “legitimate peripheral participation”, although it takes place as an active process in both circumstances (Dias, & Paré, 2000). Consequently, theoretically speaking, it is accepted that learning experiences in classrooms (facilitated performance) are not the same within communities of practice (attenuated authentic participation or legitimate peripheral participation) (Rounsaville, 2012).

This sociocultural approach has been also designated as a “vertical model of literate development”, because the model conceptualizes development in terms of learners moving through a set of phases or stages within a particular community of practice. In this perspective, development is the result of increasing participation within a particular community’s activities and practices through repeated engagement over time. Therefore, writing growth is seen as the product of increasingly deeper and fuller participation within a particular community’s engagements by which newcomers acquire greater identification with the community’s knowledge and skills as they move along a trajectory from the periphery toward more central locations, not just through repetition over time, but through an increasing awareness of the community’s beliefs, values, and interests (Wardle & Roozen, 2012).

However, a sociocultural approach also acknowledges that people can participate in different communities of practices; thus, it is accepted that development is also related to how people reutilize knowledge (transfer knowledge) across different and new situations. Accordingly, writing development is also interconnected with theories of knowledge integration (transfer), because people display levels of development (growth/competence/expertise) to the extent they face new situations by repurposing what have learned across contexts and time (synchronically and diachronically). Thus, writing transfer refers to a writer's ability to repurpose or transform prior knowledge about writing for a new audience, purpose, and context (Moore, forthcoming). Since people have to create connections, this phenomenon has been also called "knowledge integration" (Nowacek, 2011). Knowledge integration is one of the most important educational goals, since school settings aim at preparing students for flexible adaptation to new problems and new contexts, especially to participate in non-schooling contexts (Bransford, John, et al., 2000).

Speaking from a cognitive point of view, it has been suggested that transfer and knowledge integration is associated with generalization (i.e., when learners draw their conclusions to create personal theories about what they have learned) (Wardle, 2007). However, generalization is not necessarily achieved by getting good grades or accomplishing successfully goals of the courses. Engaging but not challenging assignments might help students achieve the goals of the course but achieving those goals does not necessarily require any generalization of new skills (Wardle, 2007). Therefore, integration knowledge (transfer) implies generalization that is a complex phenomenon in which "knowledge" from far contexts is reutilized in contextual and local situations. As a result, acts of integration (and generalization) will involve changes in both individuals and social organizations and imply creating associations among social situations in which "potential knowledge" to be repurposed has been acquired (Rounsaville, 2012).

Acts of integration ensue when people identify similarities and differences among contexts/situations by using metacognition to gain awareness of the demands of new situations (Yancey, Robertson & Taczak, 2014). To better understand why metacognition is useful in doing transfer, activity system theory[45] has been useful. Some scholars claim that

[45] Theoretical category to explain social activity and its organization/reproduction by making visible the overlap and natural contradictions emerging from the interaction between a) social goals of communities/groups and

activity systems overlap as a result of individuals' participations across contexts. If changes are not so salient for people, transfer only require application, but if changes are radical, the demands of novel integration might be higher (Nowacek, 2011). If contradictions are perceived among activity systems, the differences among contexts are acknowledged as something that is not natural, normal, or expected; therefore, people consciously face psychologically a double bind (i.e., an emotional disturbing dilemma in which an individual, or group, receives two or more conflicting messages, and one message negates the other). Such contradictions may become opportunities to transfer and learning (learning by expanding) (Nowacek, 2011).

However, noticing contrasting contexts/situations is not a spontaneous process nor even making comparisons is sufficient to gain awareness. Therefore, writing knowledge integration is positively affected by genre awareness as well as opportunities/affordances provided by contexts/situations. One of the contextual conditions that seems to favor integration knowledge is when personal learning motives of students dialogue with learning opportunities offered by context (kairos[46] as occasions for learning) (Dias & Paré, 2000). However, while immersion offers possibilities for learning, lack of preparation, slowness of the learning process, and ineffective writing performance may hold back such learning (Beaufort, 1999). In other words, learning how to write only by immersion and only trusting on personal learning motives might end up in "negative transfer", which means writing knowledge is repurposed but does not fit into the new writing task and its demands (also called "inappropriate repurposing").

personal motives of individuals within and across organizations/communities/groups, with b) division of labor, social roles, hierarchies and power, systems of values, status quo vs. innovation, and access/creation of artifacts (either material or symbolic).

[46] *Kairos* is the rhetor's ability to select and/or create an opportune moment to act proportionally (Artemeva, 2009).

By considering the role of personal motives and identities in knowledge transfer, theorists have claimed that students are always agents of integration. This means that there is no "negative transfer", since students as human beings are always meaning makers, which implies that even apparent instances of "negative transfer" are really moments of creation. Nevertheless, the concept of "negative transfer" acknowledges that there are constraints and agencies at play in making connections: within constraints, students "see connections", and within agencies students "sell connections" (Nowacek, 2011). Within schooling environments, when attempts of knowledge integration fulfill teachers' expectations, then such integration endeavors are visible (Nowacek, 2011; Moore, forthcoming); if not, instructors overlook attempts of integration ("negative transfer"), since students seem not to see specific connections expected by instructors (Nowacek, 2011).

Since this study collects data within a major in Industrial Engineering, the next section incorporates an overview of specific features of disciplinary and professional writing and communication in engineering.

2. Writing and communication in engineering

Acquiring a discursive identity as a scientist is one of the goals of pedagogic initiatives in engineering programs. Some pedagogic initiatives support students to discovery and solve problems as they were professional scientists constrained by time and resources (Lerner, 2009). These experiences have shown that developing representations of diverse rhetorical situations, especially of audiences of professional genres activated by writing assignments, seems to be challenging. This situation is explained by the differences and even contradictions between activity systems of academia and workplace, and particularly the personal identities that students already hold while they are participating in the pedagogic experience (e.g.,. students who envision their careers as scientists rather than in the industry and vice versa). Consequently, considering life projects of students is necessary to help them to deal with contradictory expectations from different activity systems, including expectations they must fulfill not only as future members of a professional communities of practice but also as actual students in their institutions (Lerner, 2009).

These experiences also complicate the pedagogic notion of authenticity of writing tasks, especially when students do not yet hold insider knowledge of the community with which to face the writing tasks. Despite a lack of insider knowledge, students can still value writing experiences insofar they have developed disciplinary or professional identities that allow them to make generalizations about future applicability of learning experiences. In case of students have not developed antecedent genre knowledge associated with a specific writing tasks, instructors' feedback seems to be crucial for giving them opportunities to take advantage of learning environments (Lerner, 2009).

Regarding learning experiences based on writing to learn[47] for students in sciences, it seems that writing lab reports leads students to learn particular scientific concepts by making stronger connections between lectures in which concepts were taught and the labs in which concepts are applied. Students demonstrate having enhanced awareness of domain concepts when writing is used for synthesizing, ordering, reflecting on, and interpreting scientific concepts. As a result, writing lab reports seems to lead students to engage in effective learning strategies they may not have otherwise employed (e.g., finding out more about the

[47] Carter et al., (2007) cite Broadhead, 1999 (p. 19) to differentiate two approaches "writing to learn—i.e., writing as a means of acquiring information, understanding concepts, and appreciating significance in any discipline . . . [versus] learning to write—i.e., acquiring the socially-mediated communication skills and genre knowledge appropriate to a specific discipline" (Broadhead, 1999, p. 19).

scientific concepts of the labs, and asking questions during the labs) (Carter, Ferzli & Wiebe, 2007).

Furthermore, the same genre, lab reports, can be also utilized to contribute in developing scientific identities. Disciplinary courses that aim at understanding writing lab reports as embedded process in scientific research (not only as means to learning scientific concepts) emphasize on deliberate rhetorical choices that scientists make while they interpret findings according to intended publications and audiences. Within these pedagogic approaches, developing disciplinary identities is related to developing rhetorical knowledge of scientific writing practices (Poe, Lerner & Craig, 2010).

A systematization of this type of pedagogic intervention highlights the following insights about teaching and learning how to communicate scientific data: a) Students follow a developmental trajectory that begins with talking about what they are doing methodologically and moves toward discussing why certain data are interesting within the field; b) Different communicative genres lead to different learning experiences in understanding how to use scientific data (e.g., conference proposals, grant proposals, and research articles); c) Faculty feedback and authentic professional feedback guide students in developing their understanding of using data for making scientific arguments provided that students have enhanced their knowledge of the subject matter and the expectations of discourse community (i.e., scientific values and dialogues of the community); d) Students learn when and how to trust on data, which means realizing when they have achieved “an interesting finding” and the best way to explain it (Poe, Lerner & Craig, 2010).

Furthermore, some scholars have proposed that engineering curricula should be designed based on the interconnectedness of course assignments (capstone projects achieved across sequences of courses). This curriculum arrangement provides students with better opportunity to develop engineering rhetorical strategies, which are inextricably linked to engineering contents and “audience proximity” (Winsor, 1996). In doing so, students should actually interact with a range of readers, such as peers, instructors, and practitioners (Artemeva, 2005).

The role of audiences other than instructors is particularly important in writing classes if students hold incipient professional identities; for instance, when students are asked to write research essays on a disciplinary concept that are addressing peers and by enacting an identity of a researcher claiming the effectiveness of a specific research method. However, according to pedagogic experiences systematized, students ultimately perceive pedagogic experiences differently based on: prior professional experiences in laboratories, how they conceive scientific writing, expectations of students from the course, and the degree to which they have developed identification with their careers (Lerner, 2009).

Abilities to design and innovate are also disciplinary learning expectations in engineering. Design is deemed as the integration of creativity, knowledge, skills, and team collaboration to solve problems by achieving solutions that are highly quality, innovative, low cost, and done quickly. Particular attention is given to build skills for identifying customers’ needs, and designing objectives accordingly that will be translated to specifications for the design. This means that engineering students must learn abilities of problem solving by developing innovative solutions; therefore, abilities on visualization, calculation, experimentation, and modeling are also taught. Additionally, management abilities for learning groups are seen as fundamental for successful design (i.e., teamwork, project management, oral and written communication, and documentation) (Swarts, & Odell, 2001).

The disciplinary learning expectations just described confirm that engineering students must learn how to write collaboratively. Some experiences have shown that these curriculum opportunities allow students to gain audience awareness, especially of nonacademic audiences, because students write and present orally their projects to audiences comprised by a diverse team teaching (i.e., sponsors, industry professionals, senior peers, and instructors) (Poe, Lerner, & Craig, 2010). These initiatives have relied on a broad team teaching, since writing instructors lack of insider knowledge as they are not practitioners of the field (Swarts, & Odell, 2001). Team teaching experiences also provide opportunities to learn about differences among corporative genres such as: design documents, proposals and reports, briefings and presentations, memos and letters (as deliverables used in project management or project milestone reports) (Poe, Lerner, & Craig, 2010). The student teams write this variety of genres to document group processes and present design proposals by emphasizing innovativeness, low cost, manageability, practicality, and suitability (Swarts, & Odell, 2001).

This overview confirms that there is a tendency to link the development of a scientific and academic identity with learning academic/scientific genres (rhetorical knowledge of scientific writing and data creation and visualization)that embrace the professional identity (engineers solve problems efficiently through technical and scientific designs, innovation, and teamwork). This tendency seems to locate engineering as an academic field even in workplaces environments in which practitioners enact professional genres that constantly fluctuate between academia and corporations (e.g., scientific research articles, grant proposals, editorial rebuttal, business plan, design documents, proposals and reports, briefings and presentations, memos and letters). These connections are challenging for students because the interaction among the activity systems of university (as learning site), academia (as site of knowledge production), and workplace (as site of profit production and innovation) engender sharp contradictions. Furthermore, the initiatives have also advocated for learning scientific concepts through writing (writing to learn science), which has been useful to keep proving the cognitive role of academic genres (writing lab reports or research essays) in acquiring scientific knowledge.

In order to consider the experience of disciplinary writing development throughout a student's major experience, then, it is also important to consider the context in which that development occurs, and to identify what skills are emphasized within such major. The pedagogic initiatives here, for instance, acknowledge the importance of developing skills to work collaboratively (management abilities and team work), especially to gain reader awareness (audience proximity) of an interdisciplinary audience (scientific readers, sponsors, and industry professionals) that, as practitioners, engineers will address in workplace environments and academia.

Given the amount and complexity of the learning that engineering students should acquire over time, the most salient curriculum tendency in the literature reviewed is the design of sequences of courses to support systematically and progressively students learning by achieving capstone projects that resemble, as much as possible, situations of practitioners, who are navigating among activity systems of academia, research agencies, and corporations.

C. Retrospective accounts of writing experiences and writing assignments of Colombian undergraduate students in Industrial Engineering

To explore writing variation to learn and become practitioner in a Colombian major in Industrial Engineering, this study creates accounts of writing variation by curriculum years (freshman, sophomore, junior, and senior) through exploring retrospective accounts of writing experiences and analyzing writing assignments of undergraduate students. The accounts were collected by a qualitative survey about writing experiences within the major and the samples analyzed were associated with the experiences reported by the participants in the survey.

Before presenting data collection and analysis, it is important to point out the following features of the undergraduate program from which data has been collected[48]:

The university in which the major is offered is a private university that was established in 1970. The student population is about 8,450 students and the university is comprised of 651 faculty members. The institution includes 4 faculties: Engineering, Sciences, Economics and Business, and Communication.

The Program in Industrial Engineering was founded in 1971; although, as an undergraduate program, the major dates since 1958 in Colombia. The curriculum is arranged in 10 semesters (16 weeks each) for daytime and night students. Current students complete the degree with 174 credits/units distributed as follow: 88 credits for core education, which includes 58 credits for courses on mathematics, physics, and chemistry, and 30 credits for courses on ethics, political science, five English courses, and a freshman composition course in Spanish; the courses for core education are only offered for engineering majors except from English courses. The remaining 86 credits include 68 credits for professional specialization, and 18 credits for elective professional courses. Since 2011, Industrial Engineering students must enroll in the eighth semester a senior thesis research seminar led by disciplinary professors aiming at supporting on writing their proposals; during the tenth

[48] The information presented in this section was consulted during March 2014 through the website of the University. An extended version of this information was already presented in chapter 3.

semester they must enroll a research thesis course to be advised by a supervisor, which could be seen as an independent study in the U.S. Higher Education system.

1. The qualitative survey

1.1. Data creation and analysis

Data was created through a qualitative survey in Spanish applied by paper in summer 2014 to 152 undergraduate students of a day and night engineering program in a Colombian university who decided to participate voluntarily. The survey titled "writing experiences in college" was comprised of 19 questions (appendix 1). Some questions included either checkbox responses or short answers, for instance the following questions:

8. Admission year
9. Gender (F/M)
10. Day student (Y/N)
11. Major name
18. Is this assignment similar to others you had done in other experiences in the program?
    Yes
    No
    If so, please provide the following information:
    Name of the experience:
    Topic:

Other questions boost open answers for retrospective accounts of writing experiences, as shown below:

13. What advice you would give to incoming students to face the same assignment?
14. What is the relationship of the assignment with the class?
15. What was the instructor's goal?
16. What you learned from that experience?

And some questions combined checkbox responses, short answers, and open answers as follows:

17. Select if the writing experience you described was positive _____ or negative ______
    Justify your answer with at least 1 reason

Descriptive statistics was applied to summarize qualitative tendencies across participants' responses, when provided.

The first section of the survey collects information regarding *factors that might impact how students describe their writing experiences*: admission year, genre, day/night student, name of the major, reasons to select the major, and prior or present job experiences related to the major.

The next section asks for descriptions of memorable writing experiences in the major, either positive or negative by exploring the four following aspects:

1) *Situational factors associated with the writing experience* as "a literacy task" such as: name of the assignment, topic, amount of pages, name of the course, semester, and year.
2) *How students make sense of the writing experience* by asking: the relationship among factors such as the writing assignment and subject matter, and instructor' goals tied to the writing assignment.
3) *What students can grasp/learn about the experience* by asking: lessons learned from the writing assignment, and suggestions for incoming students.
4) *Knowledge that students can reutilize* by asking them to deem the writing assignment reported as positive or negative, and its similarities when compared to others they had experimented in or outside of the program.

The last section of the survey asked for volunteers interested in providing writing samples of the writing assignments they reported in the survey. Appendix 2 includes a table summarizing participants' recruitment.

1.2. Results

1.2.1. Factors impacting how students describe their writing experiences

The profile of the survey participants suggests that the tendencies of the results might be primarily associated with writing experiences of industrial engineering undergraduates (102 cases) who were male daily sophomore and junior students and have had, in many cases, prior experience (84 cases) and current working experiences (41 cases) in the field when the survey was applied. It seems that the participants have developed a professional identification, since the reasons associated with pursuing the major are primarily pointing out professional reasons to have selected the program (e.g., This major fulfills my job market and professional aspirations: 51 cases; Industrial engineering is the most complete major in terms of managerial knowledge: 19 cases; and, I wanted to learn about production process and how to conduct projects that improve companies' efficiency: 10 cases).

1.2.2. Situational factors associated with the writing experience

When the participants responded about the topic of the writing assignments, table 1 shows that they mentioned either the topic of the assignments (which can be professional, humanistic/social, or research topics), or the name of the courses in which the assignment was conducted (table 1).

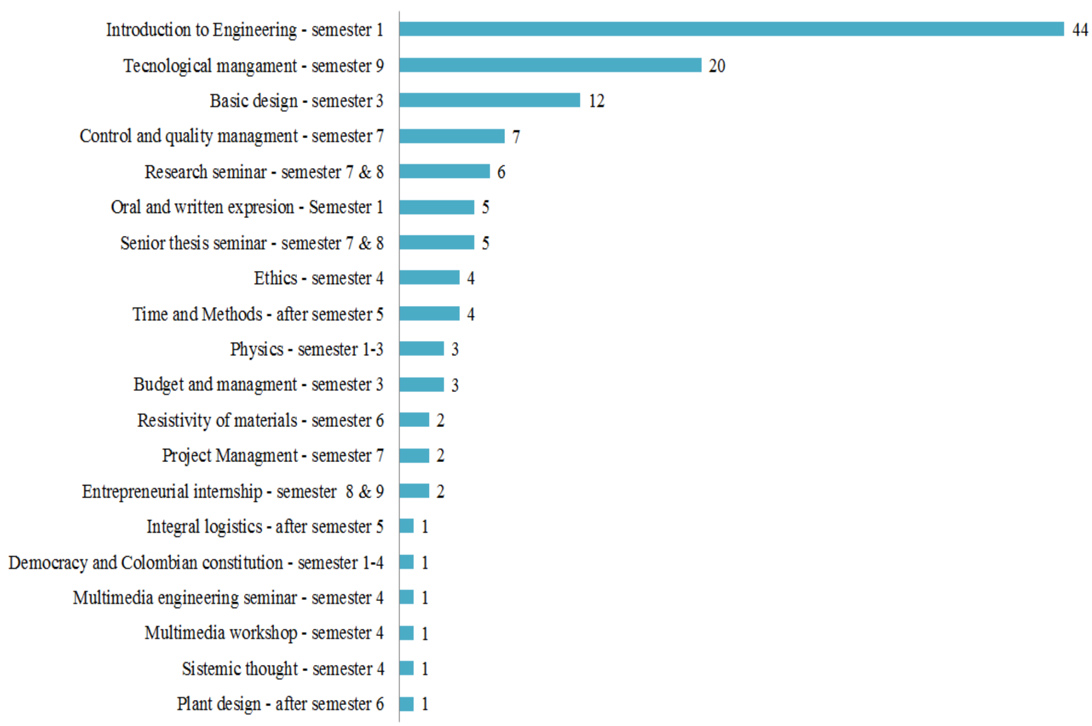
Table 1
Types of responses for "the topic of the writing assignments"

Topic or course	Curriculum year of courses	Responses	# Cases
Professional topic		Mejoramiento	9
Course	Senior	Gestión tecnológica	9
Course	Sophomore	Diseño	9
Course	Junior	Calidad	8
Course	Junior	Financiero	8
Course	Senior	Investigación	8
Professional topic		Energías alternativas	3

Course	Junior year	Aplicación de método y tiempo de trabajo	2
Course	Senior year	Aplicación del concepto logística	2
Humanistic/social topic		Mi futuro	2
Research topic		Formulación de proyectos	2
Course	Junior	Localización-diseño de planta	1
Professional topic		Natural Gourmet	1
Professional topic		Eficiencia	1
Humanistic/social topic		Adopción por padres homosexuales	1
Professional topic		Entretenimiento tecnología para *baby boomers*	1
Professional topic		Aplicación electrónica digital	1
Research topic		Potencialidades pseudotallo plátano	1
Course	Senior	Gerencia de proyecto	1
Professional topic		Elaboración manual procedimientos	1
Professional topic		Sistema de salud	1
Professional topic		Distribución	1
Professional topic		Instrumentos modulares	1
Professional topic		Sistemas de transmisión de potencia	1
Humanistic/social topic		Barrio social	1
Course	Junior	Resistencia de materiales	1
Professional topic		Contaminación aire	1
Humanistic/social topic		Pérdida cultura en Cali	1
Professional topic		Metodologías ágiles	1
Humanistic/social topic		Vida y obra de Andrés Caicedo	1
Professional topic		Portamaquillaje adaptable a vehículos	1
Course	Junior	Líneas de producción	1
Research topic		Sala a base de polímeros	1
Research topic		Polímeros para fabricación de objetos	1
Humanistic/social topic		Proceso de paz	1
Hard science topic		Biología	1
Humanistic/social topic		Análisis del arte del museo universitario	1
Professional topic		Problemática agua sin ser tratada	1
Humanistic/social topic		Educación e historia de Cali	1
Humanistic/social topic		Tauromaquia	1
Total of cases			91

If the name of the classes in which the writing assignments were conducted are organized by semesters according to the current curriculum, the distribution of the cases in figure 1 suggests that the survey participants primarily recalled writing experiences undertaken in freshman years (44 cases for the course Introduction to Engineering enrolled in freshman year), and in senior years (20 cases for the course Technological Management enrolled in senior year). Fewer mentions were made for the courses Basic Design enrolled in 3rd semester (12 cases), Control and Quality Management in 7th semester (7 cases), and Research Seminar enrolled between 7th & 8th semesters (11 cases).

Figure 1
Classes in which writing assignments were conducted



The analysis of the distribution of semesters and classes in which the writing experiences mentioned by the participants were undertaken suggests that students are recalling writing experiences from freshman years (27 cases in 1st semester and 24 cases in 2nd semester), sophomore years (19 cases in 6th semester), and senior years (16 cases in 6th semester).

The analysis also shows that distribution of the mentions of the classes and the semesters do not match. This situation might have happened because the survey participants recalled the name of the classes and the semesters, but when classes are organized by semesters according to the current curriculum distribution, the information provided by the surveyees do not coincide with the curriculum.

Overall, both of these two distributions about the classes and semesters show that the survey participants were exposed to writing experiences throughout different courses of the program and it seems that there is a trend of recalling the presence of writing experiences at the beginning and at the end of the program.

The number of pages of the writing assignments that were mentioned by the survey participants spans between 2 and 264 pages. The occurrences of the cases show that there is no pattern of number of pages across the writing assignments mentioned: 10 pages (9 cases), 70 pages (9 cases), 30 pages (9 cases), 40 pages (9 cases), 50 pages (6 cases), and 20 pages (5 cases). The average of the pages reported by the participants is 46.6 and the median is 34.5.

1.2.3. How students make sense of the writing experience

The surveyees reported in 121 cases that the writing experience they described was related to the classes. The distribution of the reasons provided by the surveyees to justify this response suggests diverse writing functions across the experiences. According to the responses, writing was useful to apply content knowledge of the classes (19 cases); communicate ideas (18 cases); boost learning of research and industrial issues (17 cases); write clear conclusions for readers (15 cases); and, help in ideas development (10 cases).

When the surveyees described the instructors' goal for assigning the writing assignments, several writing functions emerged once again from the participants' responses, some related to ideas development, others to research writing or senior thesis writing, and some about applying contents and assessment; the following were the most frequent mentions:

1. Developing skills to express ideas (49 cases)
2. Preparing students to conduct a senior thesis (19 cases)
3. Applying content knowledge of classes based on professional contexts (15 cases)
4. Preparing students for professional experiences (14 cases)
5. Assessing class topics (11 cases)
6. Learning on research and analysis (10 cases)

1.2.4. What students can grasp/learn about the writing experience

Regarding what they have learned from the writing experiences, the participants' responses confirm that writing embraces diverse functions within participants' experiences. These functions can be grouped, according to the most frequent mentions, in writing to learn (Writing about technical concepts: 30 cases), writing to think (Organizing ideas before writing: 16 cases), and writing to research (How to frame a project -- Ability and fluency for presenting projects: 18 cases; Research and structuring ideas: 15 cases; Framing problem statements, introductions, and conclusions: 11 cases)

Concerning to the surveyees' advice for incoming students to face the same writing assignment, the responses suggest that:

a) writing in this major is intertwined with reading (advice mentioned: "Conducting readings": 34 cases);

b) writing is not rejected by the engineering students, instead it seems to be important to learn in the major (advice mentioned "Taking advantage of the writing experience": 22 cases); and,

c) the writing assignments they described were primarily solitary experiences in which it was taken for granted that students already knew how to write –preparedness-, or they would have learned about writing in contexts other than the actual classes in which the writing experiences were undertaken (e.g., advices such as: “developing good writing skills and reading comprehension”: 12 cases; “investing time for independent study”: 11 cases; “starting developing early the project”: 5 cases).

However, it seems that some of the survey participants had participated in writing assignments conducted under pedagogic interventions (mentions such as: “Taking advantage of the instructor advice and feedback”: 8 cases, and “Participating in all the activities of the class”: 5 cases). Only in 6 cases, the participants mentioned the importance of “developing a precise point of view”, which might suggest that for them the writing experiences must have required audience awareness and the development of ownership.

The surveyees’ responses overall suggest that writing assignments throughout the major embrace diverse functions and developmental paths accordingly. The writing functions identified for the writing assignments are:

1. Writing to learn (thought development, organizing ideas)
2. Writing to apply content knowledge (assessment)
3. Writing to research
4. Writing to conduct a senior thesis
5. Writing to communicate ideas

Their responses were triangulated to articulate how the participants talked about the relationship among the writing assignments, the class and instructors’ goals, and what they had learned (presented in appendix 3). This triangulation of the types of responses of the participants might suggest that writing development in this major implies the students travel diverse paths to grow as writers and such paths might or might not be overlapped. For instance, writing to learn and writing a senior thesis. In the first case, the writer should "develop strategies to control thoughts and inscribe them coherently when not necessarily she is addressing a specific reader"; whereas, in the second case, in writing a senior thesis, the students should "master over time how to develop problem statements by justifying problems to specific readers".

In the case of writing to apply content knowledge (assessment), it seems that students are expected to "deploy growth in incorporating disciplinary lenses to describe professional matters (industrial issues)", but in doing so, it seems that this writing practice might overlap with writing to learn, since this content application implies "organizing ideas before writing by incorporating technical concepts without addressing an audience". Similarly, writing to research (mentions such as: learning on research and analysis: 10 cases; how to frame a project and ability and fluency for presenting projects: 18 cases; and research and structuring ideas: 15 cases) is a writing practice that is interacting with writing a senior thesis.

1.2.5. Knowledge that students can reutilize

In 126 cases, the surveyees reported that the writing experience they described in the survey was regarded as a positive experience in the major. The five most frequent reasons provided by the surveyees show the participants perceived diverse benefits from the experiences: a) writing improvements (23 cases); b) professional growth (mentions as "this experience contributed to my professional development", 20 cases, or as "learning and mastering class topics", 11 cases); c) learning about specific writing conventions (mentions as "Complying with citation standards: Colombian norms: ICONTEC, "coherence between writing and thought", "developing ideas deductively from general to specific details", 10 cases); and, d) the experience encouraged them to read (mentions such as “It helped me to get interested in reading”, 4 cases).

The reasons justifying negative writing experiences were more related to a lack of prior knowledge to face the assignment, mentions such as: I did not have enough background (14 cases), or related to writing expectations from faculty that were more academic-oriented than professional-oriented (i.e., the mention: The university is out of context with overly academic work, 1 case).

The survey participants in 50 cases thought that the writing experience they described in the survey was similar to others they had had in the program; whereas in 86 cases, the writing experiences seemed to have been new for them.

When information was provided about the name of the prior and similar writing experiences, these mentions show that students recalled:

1. The name of a genre: reports (12 cases).
2. The name of specific courses:
    - Introduction to Engineering enrolled in freshman year (7 cases).
    - Operation Managment enrolled in senior year (4 cases).
    - Methods Engineering: enrolled in junior year (4 cases).
    - Research seminar enrrolled in senior year (1 case).
3. The name of specific writing assignments:
    - Design on implementing a garbage truck (2 cases)
    - Growing edible fungi (1 case)
    - Environmental Management System Manual (1 case)
    - Essay on Colombian economy (1 case)

When information about the topic of the similar and prior writing experiences in the program was provided by the participants, the mentions show that the students tend to:

1. name a genre: reports (8 cases) was a tendency in recalling their writing experiencies.
2. name professional practices:
    - product design (5 cases)
    - engineering application (5 cases)
    - application of operation concepts (3 cases)
    - project formulation (1 case)
3. name specific courses:
    - Business management - Senior year (1 case)
    - Principles of Economics - Junior year (1 case)
    - Study on methods and time - Junior year (1 case)

The survey participants in 31 cases thought that the writing experience they described in the survey was similar to other they had had outside of the program; whereas in 89 cases, the writing experiencies were not similar to writing experiences they had outside of the program.

When survey participants provided information about the name of writing experiences that had outside of the program and were similar to the writing experiencies they described, their mentions show that naming "reports" is a trend to recall (8 cases for "reports" and 7 cases for "school reports"). Other contexts associated with the writing experiences they described were:

1. schooling experiences:
    - School reports (7 cases)
    - Sexual education in society – school program (1 case)

- Transversal technology project in the school (1 case)

2. other university experiencies:

    - university workshop on reading and writing (1 case)
    - courses within the major: (oral and written communication: 4 cases; operation managment: 2 cases; and project on process fixed assets: 1 case)

The responses about prior experiences within and outside the major that were similar to the writing assignments described suggest overall that survey participants did not perceive articulation among writing experiences throughout the major or their individual writing trajectories. This perception of facing writing assignments as new and demanding writing experiences might be also associated with the students' perception that writing in the major is a solitary endeavor. In the cases the students were able of making connections between writing experiences, they mentioned the name of a genre (within the major: reports, 20 cases, and outside the major: school reports, 7 cases), and specific classes. For this latter, once again, the emerging hypothesis is that the survey participants were more exposed to writing experiences at the extremes of the program, since they mentioned the following classes: Introduction to Engineering enrolled in freshman year (7 cases); Operation Managment enrolled in senior year (4 cases); Methods Engineering: enrolled in junior year (4 cases), and Research seminar enrrolled in senior year (1 case).

2. Writing assignments of Colombian undergraduate students in Industrial Engineering

This section analyzes writing assignments associated with the writing experiences described by the participants in the survey. This analysis will be later triangulated in the discussion section with the prior analysis of retrospective accounts of writing experiences and the literature review to describe development of writing variation within a Colombian major in Industrial Engineering.

2.1. Data creation and analysis

The final section of the survey previously described asked for volunteers interested in providing samples of the writing assignments they reported in the survey. This section thus includes the analysis of nine writing samples that were collected by e-mail between August and December 2014 from students who decided to voluntarily provide the files of the assignments they described in the qualitative survey. Appendix 4 summarizes the title of the writing assignments and the students' profile (genre, day/night students, and curricular year in the major when they responded the survey).

The following 10 criteria were used to analyze the samples by organizing descriptions and inferences in an excel table: (1) curriculum years in which the writing assignments were undertaken (freshman, sophomore, junior, and senior); (2) number of authors/students; (3) the length of the assignments in pages; (4) genre type; (5) types of problems addressed in the papers and types of organizations associated with the assignments; (6) writer identity/discursive voice; (7) textual arrangement/structure; (8) writing processes; (9) the presence of visuals in the samples; and (10) number of references cited.

Criteria 4-10 is described in table 1. The analysis of writing samples was focused on describing rather than evaluating positively or negatively their linguistic characteristics (e.g., grammar adequacy, logical coherence, or spelling).

Table 1
Description of criteria 4-10

#	Criteria	Description
4	genre type	Naming the genre by the same name used by the participant to refer to the genre or the name that is displayed by the writing sample (Coutinho and Miranda, 2009). If name is not provided, inferring the genre type from linguistic and non-linguistic markers that evoke prior knowledge of the analyst and her knowledge about the communicative context in which the samples were written (Coutinho and Miranda, 2009; Nesi, & Gardner, 2012).
5	types of problems addressed in the papers and types of organizations associated with the assignments	To better understand the interplay between writing and professional practices undertaken by students in their assignments, the analysis of the sample aimed at creating grounded categories to describe, when possible, a) types of problems/topics addressed by the reports, and b) types of business and companies associated with the senior thesis reports.
6	Writer or discursive identity/voice	Inferring discursive identities from textual linguistic markers based on prior knowledge of the analyst regarding genre types and her knowledge about the communicative context in which the samples were written (Hyland, 2004; Martinez et al., 2004; Coutinho and Miranda, 2009). Especial attention is given to issues of intellectual property and strategies used by writers to create their "voices" among others embedded in the text by: Underlining the linguistic features (adverbs, adjectives, linking words, and modalization's devices) to make inferences about two types of interactive potential meaning (Stillar, 1998): a) positional: The constructed speaking/writing subject and the expression of attitudes, intentions, and evaluations, and, b) relational: Linguistic resources that construct relations between speakers/writers and listeners/readers.
7	Textual arrangement/ structure	Analysis of visual markers (changes of font, spatial distribution, organization of content sections) and linguistic markers (evaluating language, rhetorical questions, section headings) to infer the function of textual sections by making reading in-depth by paragraphs. (Martínez, et al., 2004). Identifying heading sections by table of contents or subtitles of the samples.
8	Writing processes	Using textual markers to infer strategies used by writers before and during writing the genre (Coutinho and Miranda, 2009)
9	Visuals in the samples	Grounded categories were created to describe the visuals emerging from the data.
10	# of references cited	The final section on references or bibliography of the assignments was used to sum the number of sources cited in the assignments.

2.2. Results[49]

2.2.1. General features of the sample

The distribution of the assignments of the sample by curriculum years was: 1 freshman, 1 sophomore, 4 juniors, and 3 seniors; and, the assignments were written for disciplinary classes. The number of authors/students suggests that the assignments were conducted by groups (8 cases were written by more than one author). The average length of the assignments in pages was 26, 38 and the median was 26.50. The general description of the sample is in table 2.

Table 2
General features of the sample

# sample	Title	Curriculum year	Genre	Class	# of pages
5	Project polymer (desk)	First year	Innovation project	Introduction to engineering 2	23
3	Motorcycle charging device	Second year	Innovation project	Basic engineering design	31 slides
8	Device for children with sensory hearing impairment: permanent communication kids	Junior year	Innovation project	Basic engineering design	13
4	Proposal of a technology plan for the liquor industry "The Drunk"	Junior year	Companies/business analysis	Technology management (before 2013 curriculum)	38
6	Redesign of drying kilns in the handmade brick production	Junior year	Innovation project	Technology management (before 2013 curriculum)	30
7	Getting juice sweetened with buds and leaves of sugarcane	Junior year	Research paper /laboratory report	Industrial processes	25
1	Good practices of storage	Senior year	Research proposal	Research seminar	28

[49] In this section some cases are used to illustrate the analysis. Since the original data was collected in Spanish, the cases were translated into English. These translations were done by *Ingrid Julieth Hernández Cuero*, senior student of the Degree in Foreign Languages of the *Universidad del Valle* in Colombia.

	representations risk to be certified by Invima				
2	Improvement in the area of clothing in the manufacture of gloves of bait reference	Senior year	Research proposal	Research seminar	20
9	Final project for Technology management	Senior year	Companies/business analysis	Technology management (2013 curriculum)	34
Average					26.38
Median					26.50

2.2.2. Type of genres

The analysis suggests that the most frequent genre type of the sample was the innovation project (4 cases). For instance, a junior assignment titled "Device for children with sensory hearing impairment: permanent communication kids" in which a device is designed to support communication for hearing-impaired students.

Other three genre types were identified:

1) Company analysis (2 cases); for example the case of a junior assignment titled "Technological Plan for distillery: The Drunk". In this case, the analysis was focused on the current technological situation of a distillery company to propose improvements.

2) Research proposals in a company (2 cases), which are illustrated with a senior assignment titled "Good Storage Practices in the company Risk Representations to be certified by Invima". This research proposal aims at improving storage practices in a company importing and commercializing gym equipment and machines for physical therapy.

3) A lab report (1 case) in a junior assignment titled “Final project of Industrial Processes: Obtaining sugar juice from sugarcane leaves”, in which an experiment in reutilizing leftovers of sugarcane processing is reported.

2.2.3. Types of problems and types of organizations associated with the assignments

“Creating devices that expand functions of prior ones” was a frequent problem addressed by the assignments, as is shown in the following fragment of a ppt-slide of the problem statement in a freshman assignment titled “Motorcycle charging device” in which it is proposed to design an expanding device for allowing owners to adapt its motorcycles to carry objects such as supermarket groceries:

Example 1
Freshman assignment titled “Motorcycle charging device”

Problem
Transporting a set of objects (from the supermarket), for an average family of four members, in a motorcycle for two people.

This tendency (“creating devices that expand functions of prior ones” as a frequent problem) coincides with the type of the most frequent genre of the sample (the innovation project); however, other four types of problems were identified:

1) “Complying with public policies/standards in companies” as illustrated in the following introduction of a senior assignment titled “Good practices of storage representations risk to be certified by Invima”. This case illustrates that regulations established by national agencies, as mentioned bellow “National Institute of Food and Drug Monitoring, INVIMA”, are used to determine improvements that companies need in fulfilling protocols:

Example 2
Senior assignment titled: "Good practices of storage representations risk to be certified by Invima"

INTRODUCTION
The company representations Risk is an importer of fitness equipment located in the city of Cali (...)[50]*. From this year, INVIMA established that importers of this type of machinery must obtain a certificate for storage and refurbishment of medical devices (CCAA), which should comply with requirements that are stated in the resolution 4002, 2007.* *The company was visited by INVIMA, but it was not certified because of lacking in meeting some of the requirements, since the storage area does not have areas of recruitment, office, quality, reception, quarantine, and product disposal. Therefore, the objective of this research is to advise the company to comply with these requirements in its storage area and can thus be certified.*

2) "Reducing time in production and commercialization" as shown in the next case of a senior assignment in which the student conducted a SWOT analysis (strengths, weaknesses, opportunities and threats) to bound the company situation. This assignment was related to a company producing plastic packaging containers and aimed to improve storage of raw material in the warehouse:

[50] This symbol (…) indicates that the analyst has eliminated fragments of the original case.

Example 3
Senior assignment: "Final work (technological management)"

1.1 Analysis of the SME (Small and Medium size companies) in relation to the management of current or existing technology
1.4.1 Matrix SWOT

Weaknesses	• Little space within the production plant. • The company is not certified in quality. • It is not automated. • Many manual processes.
Opportunities	• High demand for flexible packaging at the national level. • Many of the competitors are not focused on improving quality of their products. • The plant technology is easily replaced since it is regular/basic technology.
Strengths	• They have mechatronic engineers, capable of developing machines. This makes the company independent with regard to creating/designing machines. • Although they are not certified, products hold good quality. • They have the staff to develop their own technology.
Threats	• The only thing they consider a threat, it is a possible Free Treatment Agreement (FTA) with Venezuela in which the oil would be much cheaper than in Colombia. Manufacturing plastic components is based on petroleum.

3) "Reutilizing leftovers of production process" as illustrated by the next summary of the junior assignment titled "Getting juice sweetened with buds and leaves of sugarcane" in which an experiment was conducted to reusing sugarcane waste:

Example 4
Junior assignment titled "Getting juice sweetened with buds and leaves of sugarcane"

SUMMARY

This project is focused on taking advantage of the versatility that sugar cane has in terms of reuse. There are many products derived from sugar cane, from which other derivatives can result, such derivatives have had a boom on a large scale in recent years, since first generation products -such as the sugarcane extract- are products that are already in saturation stage; furthermore, these first-generation products bring negative social and health consequences. Therefore, we have worked on reusing sugar cane waste that is called second-generation, namely, "buds and leaves", which are easy to obtain in sugar mills.

4) "Identifying needs in a company" as can be seen in the next case of a junior assignment titled: Proposal of a technology plan for the liquor industry: The Drunk", in which the

analysis of the current and envisioned markets is conducted to determine standards that this specific company and its already outstanding products have to meet in terms of machinery and technology, especially to reach European markets:

Example 5
Junior assignment titled: Proposal of a technology plan for the liquor industry "The Drunk"

GLOBAL ENVIRONMENT

The "Monde Selection" award is a prize awarded by an Institute in Belgium to those wines or liquors that complying with some quality standards. The Caucan brandy has won the gold medal and diplomas of quality by this Institute. This makes The Caucan brandy well known worldwide, and allows studying the possibility of introducing such liquor in markets such as Chile, an option that is currently studied, and in other countries as Peru, Ecuador, Honduras, and some European countries. Currently, the production plant does not meet some standards required in terms of machinery and technology by some foreign countries; thus, exportation of this outstanding product of the company is difficult, and has not been possible to these nations.

3.2.4. Types of business of the companies mentioned in the samples

The organizations associated with the assignments were companies producing and commercializing state and national products (2 cases), local products (2 cases), and imports (1 case). In 4 cases the category on types of companies was non-identifiable (table 3).

Table 3
Relationships among genre type, type of problems, and type of business

# of the sample	Genre type	Type of problem	Type of business
1	Research proposal in a company	Complying with public policies/standards in companies	Importation and commercialization
2	Research proposal in a company	Reducing time in production process-selling	Production of local products
3	Presentation of an innovation project	Creating devices that expand functions of prior ones	Non-identificable
4	Company analysis	Defining financial needs in a company	Production and commercialization of state and national products
5	Innovation project	Creating devices that expand functions of prior ones	Non-identificable
6	Innovation project	Complying with public policies/standards in companies	Production and commercialization of state and national products--

			Artisanal brick production
7	Research paper (?) lab report (?)	Reutilizing leftovers of production process	Non-identificable
8	Innovation project	Creating devices that expand functions of prior ones	Non-identificable
9	Company analysis	Reducing time in production process-selling	Production of local products

2.2.4. Writer identity/discursive voice

The analysis of the writer identities/discursive voices and intended audiences across the sample suggests that in all of the assignments, the students/writers enacted at least as "Student applying content knowledge in a project" when they addressed "Instructors" (see yellow boxes in figure 3). This type of voice or discursive identity can be illustrated with the next fragment of a junior assignment titled "Redesign of drying kilns in the handmade brick production" in which the student/writer mentions in a section named "background" the "inquiries" undertaken to conduct the assignment:

Example 6
Junior assignment titled "Redesign of drying kilns in the handmade brick production"

> *According to historical inquiries that we have done the type of ovens used currently by the Brick-makers in the Region are Roman ceramic kilns dating back two thousand years old.*

Figure 3
Writer identities/voices and intended audiences across curriculum years

Sample #	Title	Genre	Type of problem	Type of business	Learning moment	Writer identity/voice 1	Intended audience 1	Writer identity/voice 2	Intended audience 2	Writer identity/voice 3	Intended audience 3	Writer identity/voice 4	Intended audience 4
5	Polymer project	innovation project	Creating devices that expand functions of prior ones	Non-identifiable	Freshman	Student applying content knowledge in a project	Intructors	Professional in innovation	Potential sponsors and consumers				
3	Loading device for motorcycle	Presentation of an innovation project	Creating devices that expand functions of prior ones	Non-identifiable	Sophomore	Student applying content knowledge in a project	Intructors	Professional in innovation	Potential sponsors				
8	Device for impaired hearing children "permanent communication kids"	innovation project	Creating devices that expand functions of prior ones	Non-identifiable	Junior	Student applying content knowledge in a project	Intructors	Professional in innovation	potential clients and sponsors				
4	Technological Plan for distillery "The Drunk"	Company analysis	Defining financial needs in a company	Production and commercialization of state and national products	Junior	Student reporting company visits or obsertations	Instrutor			Company analyst	Company owners, directives or managers		
6	Redesign of drying ovens in artisanal brick production	innovation project	Complying with public policies/standards in companies	Production and commercialization of state and national products--Artisanal brick production	Junior	Student reporting company visits or obsertations	Instructor	Professional in innovation	Potential beneficiaries	Company analyst	Company owners, directives or managers		
7	Final project of Industrial Processes: Obtaining sugar juice from sugarcane leaves	research paper (?) lab report (?)	Reutilizing leftovers of production process	Non-identifiable	Junior	Student presenting literature review	Instructor					Lab researcher stating a problem, theoretical categories, methods, results, and implications	Instructor -- other lab researchers
1	Good Storage Practices in the company Risk Representations to be certified by Invima	Research proposal	Complying with public policies/standards in companies	Importation and commercialization	Senior	Student presenting literature review	Instructor			Company analyst	Company owners, directives or managers	Researcher in engineering	Sponsors
2	Improvement proposal for a manufacturer of fleshing gloves. A3-5ia(20)t/ev	Research proposal	Reducing time in production process--selling	Production of local product	Senior	Student presenting literature review	Instructor	Company analyst	Company owners, directives or managers	Company analyst	Company owners, directives or managers		
9	Final work (technological management)	Company analysis	Reducing time in production process--selling	Production of local products	Senior	Student presenting literature review	Instructor			Company analyst	Instructor - Company owners, directives or managers		

However, in all of the assignments emerged at least another discursive identity/voice that constructed different intended audiences; for instance, in samples # 5, 3, 8 and 6, the students enacted as "Professional in innovation" who were addressing either "Potential sponsors and consumers", "Potential sponsors", "potential clients and sponsors", or "Potential beneficiaries" (see green boxes in figure 2).

The creation of these types of discursive identities can be illustrated with the following fragment of a section named "feasibility conclusion" of a freshman assignment titled "Introduction to Engineering 2"; the next fragment shows that the authority of the writer is created by describing a specific plan by addressing possible sponsors for building an area as part of an innovative project consisting in assembling a school desk for left-handed college students:

Example 7
Freshman assignment titled: "Introduction to Engineering 2"

> ***20. FEASIBILITY CONCLUSION***
>
> *The area construction where the product assembly will be carried has a space of 15 meters wide by 26 meters long, with a total of 390 square meters, with its assembly as U-shaped. The space is exactly necessary but has a goal of expansion.*

Another discursive identity/voice that emerged from the sample was "Company analyst" to address "Company owners, directives or managers" in the samples # 4, 6, 1, 2, and 9 (see blue boxes in figure 2). The next fragment of a junior assignment titled "Proposal of a technology plan for the liquor industry: The Drunk" can illustrate this type of discursive voice in a section named "capacity for innovation". The following excerpt, especially the lines underlined, shows that the writer identifies limitations in a production process of a distillery and points out an innovative proposal to reduce expenses and increase control in liquor production process:

Example 8
Junior assignment titled “Proposal of a technology plan for the liquor industry: The Drunk”

> ***CAPACITY FOR INNOVATION***
>
> *In the Liquor industry of Cauca State (ILC), there is currently a Committee of innovation or research that guides the company in the new globalized trends. This is perhaps because this company is currently the most important organization in liquor selling of the Cauca state. Despite new flavors have been developed for frosted creams recently, <u>there are no innovations for the production process; this means that new flavors have been developed to analyze customer reception, but the production process for any flavor frosted cream is no different. A factor that could be innovated would be if raw materials (bottles, flavorings, caps, etc.), which are supplied by different vendors are produced by the same company to completely control the production process.</u>*

Finally, the analysis revealed an identity/discursive voice as “Lab researcher stating a problem, theoretical categories, methods, results, and implications” or “Researcher in engineering” to address either “Instructor s and other lab researchers” or “Sponsors” that emerged from samples # 7 and 1 (see nude boxes in figure 2). This case can be illustrated with the next excerpt of a junior lab report titled “Getting juice sweetened with buds and leaves of sugarcane”; in the conclusion section, the specialized terms underlined in the next fragment confirm that the writer should master specific knowledge domain to draw conclusions, limitations, and further implications in exploring industrial applications of sugarcane leftovers:

Example 9
Junior assignment titled “Getting juice sweetened with buds and leaves of sugarcane”

> ***Conclusions:***
>
> *The process of <u>enzymatic hydrolysis</u> for the extraction of sugars from the leaves and buds cannot be cost-effective for use at the industrial level, since the costs of the necessary inputs for the process are high compared to the quantities of <u>glucose obtained</u>, preparation time is very high, and it is not possible to structure it as a continuous process. However, <u>the efficiency of the process is about 40%, which is significantly high (in theoretical terms since real glucose concentration has not been defined</u>). Therefore, more research is needed on methods for industrialization.*

Overall this analysis suggests that the writing assignments of the sample demanded the students enact four different identities/voices, which in turn created four different audiences to address. Overall, the analysis of the identities/voices and intended audiences reveals that:

- From freshman to junior assignments, the students enacted professionals in innovation to address potential sponsors and consumers (green boxes in figure 2).
- From junior to senior assignments, the students enacted company analysts to address company owners, directives, or managers (blue boxes in figure 2).
- For junior and senior assignments, the students enacted researchers (nude boxes in figure 2).

2.2.5. Textual arrangement/structure

The analysis of the formats and subtitles of the contents of the samples analyzed overall suggests that variation is highly present across writing assignments in terms of the contents and formats. Examples of these variations are described as follows:

a) In freshman assignments, students have asked to envision how their innovative ideas can be commercialized by anticipating potential customers and conducting financial studies based on market studies, and planning production processes and suppliers for machines and raw materials. For instance, the sections 7, 10, 12, 13, 14, 20, 21, and 22 underlined of the following textual structure of a freshman assignment titled "Project polymer (desk)" that proposes a design for a school desk to offer better workstations for left-handed students:

Example 10
Freshman assignment titled “Project polymer (desk)”

1. Summary
2. Project Title
3. Justification
4. Objectives
5. Type of project
6. Project planning
7. Estimation of market size
8. Identifying project demand
9. Identifying project offer
10. Conclusions on market study
11. Graphical representation of the product
12. Human resources for the project
13. Types of technology
14. Table of technological equipment
15. Graphical representation of the production process
16. Suppliers for machines and raw materials
17. Plant Distribution
18. Project size
19. Project location
20. Project feasibility
21. Financial Study
22. Feasibility conclusion
23. Webography and sources

Later, in a senior sample (# 1), a budget is included again; however, in a writing assignment that is a research proposal. This case can be seen in the section 10 underlined of the textual structure of a senior assignment titled “Good practices of storage representations risk to be certified by Invima”; this is a case of a research proposal to determine to what extent a company importing and commercializing gym equipment and physical therapy machinery complies with the Colombian standards established by “The National Institute of Food and Drug Monitoring, INVIMA”:

Example 11
Senior assignment titled "Good practices of storage representations risk to be certified by Invima"

Introduction
1. Title

2. Participants
2.1. Students
2.2. Academic director

3. Problem statement
3.1. Research question

4. Justification

5. Background
5.1. International
5.2 National
5.3 local

6. Frameworks
6.1. Theoretical framework
6.1.1. Good storage practices
6.1.2. Invima certification
6.1.3. Resolution 4002 of 16 November 2007
6.1.4. Risk representations

7. Objectives
7.1. General objective
7.2. Specific objectives

8. Methodology
8.2. Information sources
8.2.1. Primary sources
8.2.2. Secondary sources
8.3. Data collection
8.4. Project stages
9. Timeline

10. Budget

References

b) In freshman, sophomore, and junior assignments, the samples reveal as a common feature the graphic representations of innovative devices created by the students in their projects (digital graphic simulations). The following visual is an example of a freshman assignment titled: "Project polymer (desk)":

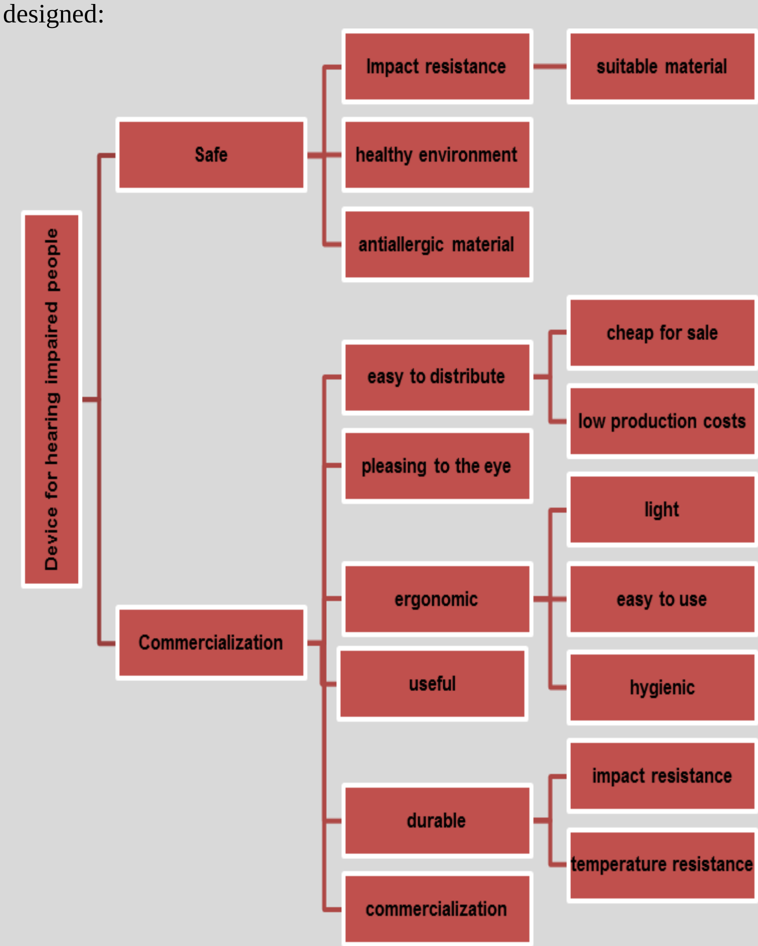
Example 12
Freshman assignment titled: "Project polymer (desk)"

c) In junior assignments, there is a case in which data collected by surveys is a strategy to define and envision the problem that will be solved in proposing the project.

d) In sophomore and junior assignments, there are sections of the projects in which writing and visuals are used to analyze situations and make decisions about the problem addressed in the project (e.g., section 11 titled “objective tree” in a sophomore, and section titled “weighted objective tree” in a junior sample). The following case of a junior assignment titled: “Device for children with sensory hearing impairment: permanent communication kids” illustrates these cases in which a flowchart is summarizing the benefits of a device designed for hearing-impaired students:

Example 13
Junior assignment titled: "Device for children with sensory hearing impairment: permanent communication kids"

Taking into account the hierarchy of the device's attributes, the following objective tree is designed:



e) From freshman to junior assignments, there are sections that suggest that the students designed the projects by contextualizing technological issues and its implications for the company/organizations or innovations. For instance, the next fragment of a freshman assignment titled "Project polymer (desk)" illustrates how the writer described the materials and procedures that would be needed in assembling a school desk for left-handed students:

Example 14
Freshman assignment titled: “Project polymer (desk)”:

> ***13. Technology Type***
>
> *In our plant we will have different types of industrial equipment with high quality and different brands. In order to start up the process of our product, we will need, first of all, the injector machines that melt the raw materials and inject them in the mold and dry the created piece. The conveyor belts are essential for the transportation and communication between the stages and the A-3 mesh type is preferred. The aluminum pieces will be chromed to have greater resistance, for this the tanks, the pressure system, and the paint guns will be used. The pieces adjustment will be done by different operators putting nuts and screws, with tools such as keys. For the packaging process there is a machine that wraps the product with stress plastic that has a Mytho rotary table. To load and transport heavy elements there are Komatsu freights elevators and for the product distribution there is a T600 Kenworth trailer truck. The quality control is done with the specialized staff that knows the physical and chemical characteristics of the product and its study to make improvements.*

f) The analysis of the company situations emerged as part of a junior assignment (sample # 4) and a senior assignment (sample # 9). In these cases, extensive sections are used by the students to contextualize and analyze the business and the company within broader contexts (international and national). This can be illustrated by the 1st and 2nd sections of the table of contents of a senior assignment titled “Final project for Technology management”:

Example 15
Senior assignment titled "Final project for Technology management"

Table of Contents

g) In a junior assignment, descriptions of the Colombian regulations for brick production are used to further conduct the analysis of how a company is complying with such, as can be seen in the table below in which the students summarize the Colombian regulations related to the project: brick production:

Example 16
Junior assignment titled: "Redesign of drying kilns in the handmade brick production"

7.1. Regulations for brick production in Colombia

Regulations	Brief description
Colombian technical standard NTC 4205	Regulates standards for different types of bricks and ceramic blocks used in masonry
Colombian technical standard NTC 4051	Defines specific norms for fired clay used in masonry, bricks, roof tiles, and the like. There is no mention about environmental requirements.
Colombian technical standard NTC 817	Determines definition, classification, chemical composition, and physical and mechanical properties.
Colombian technical standard NTC 815	Classifies thermal insulator materials known as insulator brick. There is no mention about environmental requirements.
Colombian technical standard NTC 804	Determines shapes and measurements for bricks and molded refractory parts frequently used in building and lining industrial furnaces, boiler chambers, incinerators, and vent pipes. There is no mention about environmental requirements.
Colombian technical standard NTC 676	Includes procedures to measure size, dimensions, density, warping, and orthogonality of dense and insulating refractory bricks. There is no mention about environmental requirements.

h) Across the sample, some assignments include a section titled "state of art", "literature review", or "background" (senior sample 7), other assignments include a section titled "theoretical framework"(sophomore sample 3; senior sample 7), other samples include both (junior sample 6, and senior samples 7, 1, and 2), and in other cases these sections are absent (freshman sample 5; junior sample 8; junior sample 4; senior sample 9).

i) The analysis of the final section from freshman to senior assignments, except from junior sample 2, suggests that the students had to write "conclusions"; however, only from junior assignments (sample 4 & 6), and a senior assignment (sample 9), this section is attached to "recommendations".

2.2.6. Writing processes

The analysis reveals at least 17 different types of writing processes that have been undertaken for completing the type of the assignments of the sample. Table 4 displays the occurrences of these writing processes across the samples. This distribution suggests that the most frequent writing processes undertaken to complete the writing assignments of the sample were:

- Reading and summarizing about categories related to the project (theoretical categories, norms/standards, public policies, international and national state of art on the issue) (9 cases).
- Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project (9 cases).
- Revisiting theoretical categories of the class for defining, describing the project/company/organizations, making claims, presenting proposals/recommendations, and drawing conclusions (8 cases).
- Utilizing types of graphics studied in the class to represent information of the project (8 cases).
- Searching/creating pictures (7 cases).
- Creating or taking quantitative data from other sources related to the project (6 cases).
- Summarizing information in tables/diagrams (6 cases).

Table 4
Occurrences of writing processes across the samples

#	Process	Occurrences
Process 3	Reading and summarizing about categories related to the project (theoretical categories, norms/standards, public policies, international and national state of art on the issue)	9
Process 5	Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project	9
Process 2	Revisiting theoretical categories of the class for defining, describing the project/company/organizations, making claims, presenting proposals/recommendations, and drawing conclusions	8
Process 4	Utilizing types of graphics studied in the class to represent information of the project	8
Process 17	Searching/creating pictures	7
Process 6	Creating or taking quantitative data from other sources related to the project	6
Process 11	Summarizing information in tables/diagrams	6
Process 9	Copying institutional information of companies/organizations	5
Process 13	Selecting a company/types of business to conduct a case study	5
Process 10	Conducting fieldwork on companies/organizations	4
Process 1	Identifying a need to create a new device/product (commercial idea)	3
Process 8	Creating simulation of products	3
Process 12	Identifying a problem (either in company production or a research problem to be addressed in a company production)	3
Process 7	Creating instruments to collect data related to the project	2
Process 16	Defining a timeline and budget for addressing a research problem	2
Process 14	Conducting lab experiments	1
Process 15	Keeping a journal log to track procedures of experiments and taking pictures of equipment, procedures, and materials of the experiment	1

During the analysis of the writing processes related to reading or review practices that implied making citations when information was taken from other sources (writing processes 3, 5, 2, and 9), it was striking that conventions for making explicit quotations or incorporating the references were repeatedly absent. For instance, the following excerpt of the introduction section of a freshman assignment titled: “Device for children with sensory hearing impairment: permanent communication kids”, includes underlined fragments in which the reader might expect citation practices, because the writer is describing a hearing loss by using technical terms that might have been taken from specialized readings:

Example 17
Freshman assignment titled: "Device for children with sensory hearing impairment: permanent communication kids"

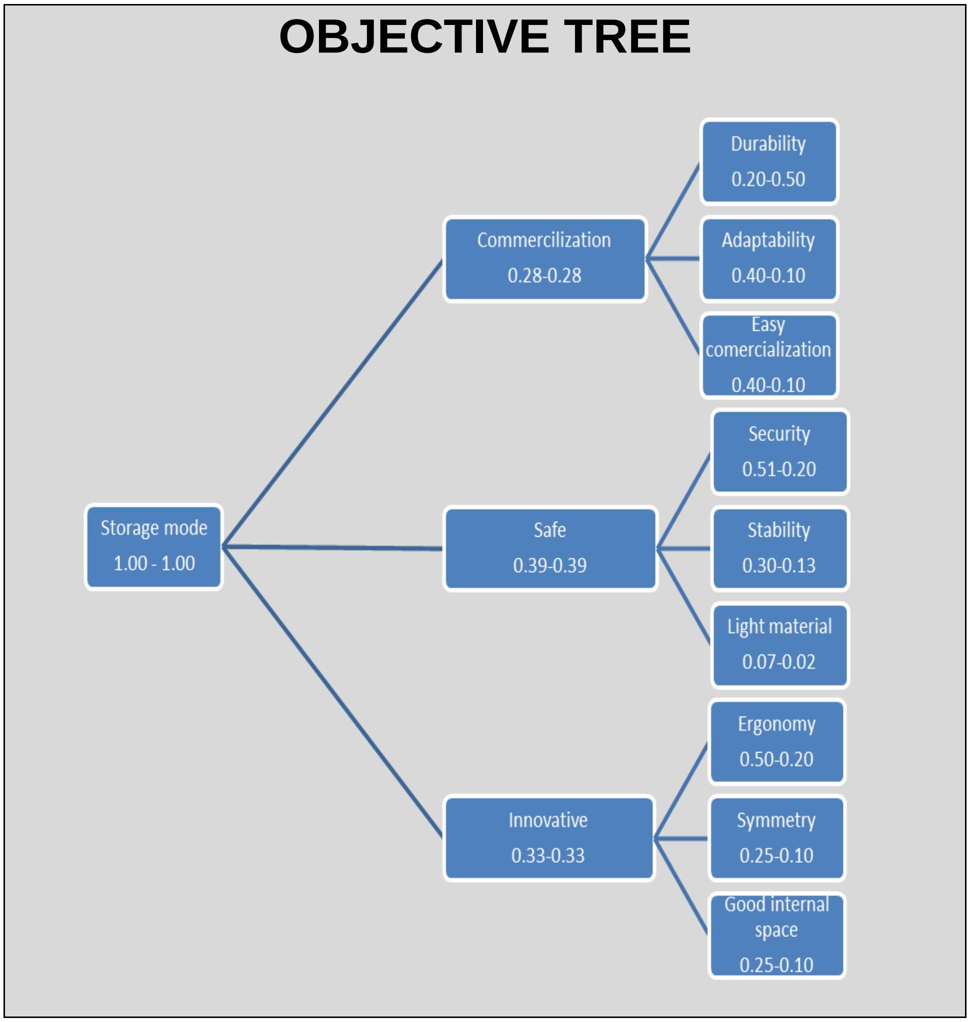
> *1. Introduction*
>
> *The work is based on a health problem that affects kids over 7 years old, having a special approach in kids from 3 years old who already have a more advanced cognitive capacity to have a friendly relationship with the device developed in the process. <u>The problematic is the permanent auditory disability that consists on a total deficit of the auditory perception known as cophosis and affects the possibility of hearing, which brings a bad development of a good communication. It can be inherited or a consequence of a trauma, an illness, a long exposition to the noise or a medicine ingestion too aggressive for the auditory nerve. It is important to clarify that these people have a great visual development, so their natural language is gestural,</u> such as the sign language that will be used in the developed device. (...)*

2.2.7. The presence of visuals

16 types of visuals were found in the samples from freshman to senior assignments (table 5). The analysis of the occurrences of the types of visuals present across learning moments (freshman, sophomore, junior, and senior assignments) suggests that the two most frequent visuals were:

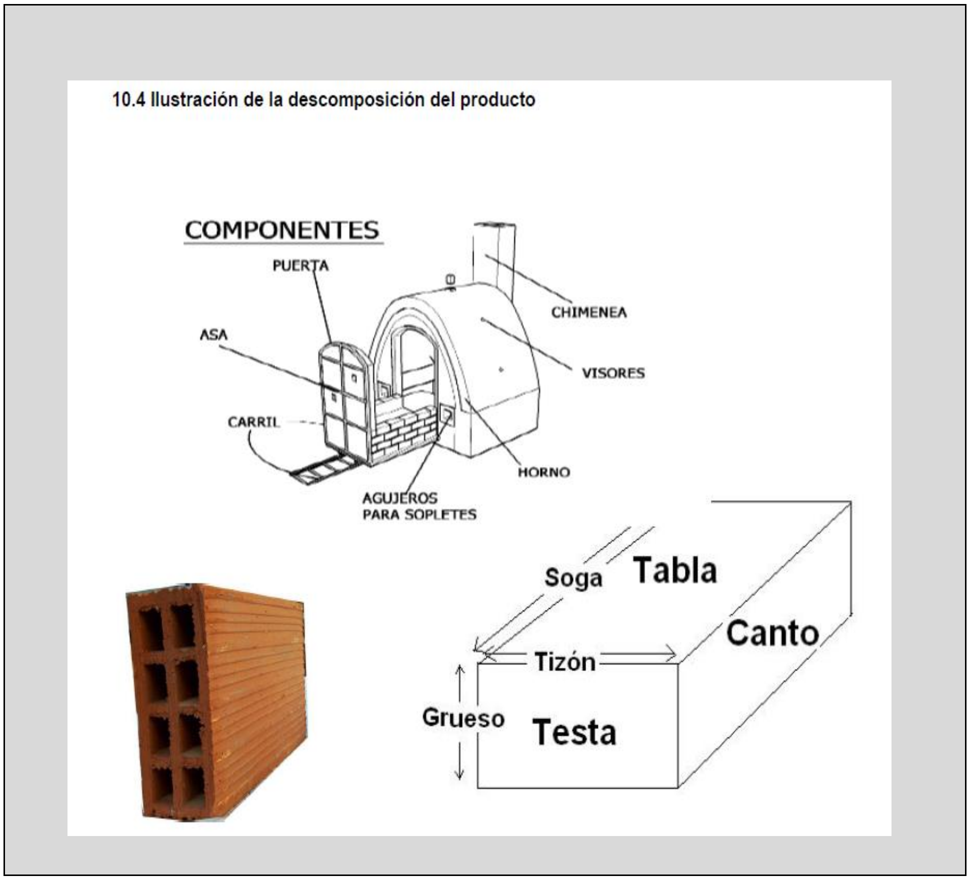
1) Diagrams to justify decisions/draw conclusions in the project (e.g., problem tree, value chain) (6 cases), as shown in the next case of a slide of a freshman assignment titled: "Motorcycle charging device" in which the features of a device to expand transportation capability of motorcycles is weighted and depicted through a flowchart:

Example 18
Freshman assignment titled: "Motorcycle charging device"



2) Pictures or drawings with types of categories related to the project (6 cases), as illustrated below with fragments of a junior assignment titled "Redesign of drying kilns in the handmade brick production" in which the visuals are describing the features of the artifacts, bricks, involved in the case studied:

Example 19
Junior assignment titled "Redesign of drying kilns in the handmade brick production":



The next frequent visuals in the sample were:

- Graphics/tables summarizing stages of production/commercialization/products in companies or for an innovation product (5 cases);
- Conceptual maps/tables for theoretical categories of the project (e.g., norms/regulations) (4 cases); and,
- Tables with quantitative data (4 cases).

Some of these visuals are primarily used as strategies to make decisions (problem tree), or report/organize information for instructors (conceptual maps).

Table 5
Types of visuals and occurrences across the samples

	Type of visual	Occurrences
1.	Pictures with types of categories related to the project (e.g., cartoons or pictures of process, materials, or products)	6
2.	Diagrams to justify decisions/draw conclusions in the project (e.g., problem tree, value chain)	6
3.	Graphics/tables summarizing stages of production/commercialization/products	5
4.	Tables with quantitative data	4
5.	Conceptual map/tables for theoretical categories of the project (e.g., norms/regulations)	4
6.	Pictures simulating the innovative product	3
7.	Tables with quantities for the project stages	3
8.	Graphics/tables summarizing technological features of the company/production	3
9.	A timeline	2
10.	Mathematical statements	2
11.	Diagram with stages of the project	1
12.	Visuals to depict factory floors	1
13.	Maps for describing production location	1
14.	Images of instruments of data collection	1
15.	Tables for describing features or requirements of an innovative product	1
16.	Organization chart	1

The samples in which the highest amount of visuals was found was in a freshman assignment (in sample 5: 7 types of visuals), and in a junior assignment (in sample 8: 5 types of visuals). Furthermore, a senior assignment (sample 2) displayed the fewer amounts of visuals (2 types).

The analysis suggests that timelines were include only in a freshman (sample 5) and a senior (sample 1) assignment, as well as mathematical statements emerged only in junior assignments (sample 8 and 7).

2.2.8. Number of references cited

The analysis of the number of sources cited in the section titled "references" or "bibliography" suggests that students had read from 3 up to 14 sources. In some cases, a list of references or bibliography was not present (samples 4 and 6); however, this might be related to the fact that some of the files provided by the participants were drafts of their final projects. The two largest amount of sources cited were: 10 for a freshman assignment and 14 for a senior assignment (table 6).

The analysis of the types of citation conventions utilized in sections of references and bibliography did not display a specific format across the sample (i.e., MLA, APA, Vancouver, or The Colombian ICONTEC format).

With the data available, it might be stated that there is no overt pattern across semesters regarding the amount of sources cited by the students to complete these assignments.

Table 6
Number of references cited in the sections "references" or "bibliography"

Sample #	Title	Genre	Type of problem	Learning moment	# of sources
5	Polymer project	innovation project	Creating devices that expand functions of prior ones	Freshman	10
3	Loading device for motorcycle	Presentation of an innovation project	Creating devices that expand functions of prior ones	Sophomo re	7
8	Device for impaired hearing children "permanent communication kids"	innovation project	Creating devices that expand functions of prior ones	Junior	6
4	Technological Plan for distillery "The Drunk"	Company analysis	Defining financial needs in a company	Junior	0

6	Redesign of drying ovens in artisanal brick production	innovation project	Complying with public policies/standards in companies	Junior	0
7	Final project of Industrial Processes: Obtaining sugar juice from sugarcane leaves	Research paper / lab report	Reutilizing leftovers of production process	Junior	7
1	Good Storage Practices in the company Risk Representations to be certified by Invima	Research proposal	Complying with public policies/standards in companies	Senior	7
2	Improvement proposal for a manufacturer of fleshing gloves. A3-5ia(20)t/ev	Research proposal	Reducing time in production process--selling	Senior	14
9	Final work (technological management)	Company analysis	Reducing time in production process--selling	Senior	3

2.3. Summary and Analysis

The analysis of this sample suggests that the most frequent type of assignment in this major might be the innovation project; whereas the experiment lab report is less frequent. Furthermore, the analysis of the types of problems across learning moments suggests that for freshman and junior assignments students are expected to solve problems related to creation of new devices (commercial ideas), whereas in junior and senior assignments students are expected to identify problems in companies or types of business by aiming at two different goals: either proposing improvements in companies/business as practitioners of the field, or conducting research projects in the context of companies/business. Only one junior assignment displayed writing and textual arrangements related to lab experiments practices (e.g., keeping a journal log to track procedures of experiments and taking pictures of equipment, procedures, and materials of the experiment).

The analysis of the assignments provided an overview of the types of problems that are associated with the system of values (ideologies) of the major: a) Creating devices that expand functions of prior ones; b) complying with public policies/standards in companies; c) reducing time in production and commercialization; d) reutilizing leftovers of production processes; and, e) identifying financial needs in companies.

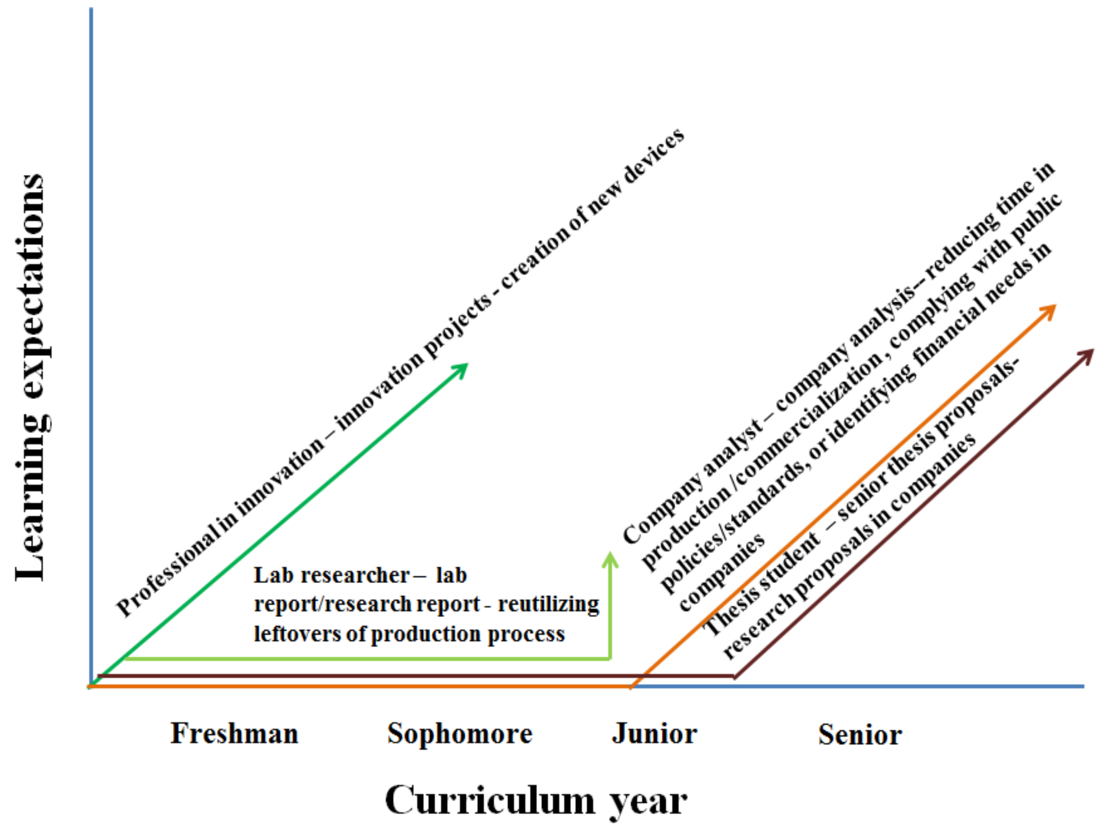
The analysis of the writing processes involved in completing these assignments reveals that students have to conduct different types of reading practices across the learning moments regardless the type of problem addressed in the assignments:

a. Revisiting theoretical categories of the class for defining, describing the project/company/organizations, making claims, presenting proposals/recommendations, and drawing conclusions;
b. Reading and summarizing about categories related to the project (theoretical categories, norms/standards, public policies, international and national state of art on the issue); and,
c. Reading and summarizing information from other sources to describe materials needed in companies/organizations or situations related to the project.

This finding is also confirmed by the analysis of textual arrangements that suggests that the samples included the following sections: “state of art”, “literature review”, “background”, and “theoretical framework”.

The analysis of the writer identities/discursive voices displayed in the texts if compared against to types of genres and problems addressed in the writing assignments shows that writing expectations across contexts (courses) are highly multifaceted and diverse type of growth is expected at different curriculum years. For instance, figure 4 is an attempt to depict types of growth in terms of writing assignments if organized across curriculum years and writer identities/discursive voices. This is, within the first year, one expectation might be to educate writers to conduct innovation projects; suddenly in junior years, students are expected to enact lab researcher identities by writing research reports, simultaneously, from this year forward, students should become writers for company analysis while also dealing with writing a senior thesis proposal.

Figure 4
Writer identities/voices, genres, and types of problems throughout the curriculum years



Because of the size of the sample and how it was collected, this developmental depiction of writing expectations for students to accomplish within the major might not be accurate; however, the analysis shows that, at least, within this program becoming an engineering writer implies enacting different identities: professional in innovation, company analyst, laboratory researcher, and researcher on company issues, which, in turn, carries out diverse writing practices that might or might not overlap (interact); thus, these expectations would impose different types of challenges for these students across learning contexts and degree-completion requirements (conducting a senior thesis).

During the analysis of the writing processes related to reading practices or literature review practices that implied taking information from other sources, it was striking that conventions for making explicit quotations or incorporating references were repeatedly absent. This coincides with the analysis of the format of the types of citation conventions utilized in the sections of references and bibliography, which did not display a specific format across the sample (e.g., MLA, APA, Vancouver, or The Colombian ICONTEC format).

The analysis of the types of visuals suggests that from freshman to senior years, these assignments demanded the students to use visuals to justify decisions and draw conclusions in the project, and summarize theoretical categories or stages related to the projects. The analysis of functions of these visuals might suggest that they are primarily addressing the thinking process of the writer, in this case an engineer analyzing a problem and making decisions accordingly (e.g., problem tree, value chain), or reporting/organizing information for instructors (e.g., by using pics or drawings with types of categories related to the project; graphics/tables summarizing stages of production/commercialization/products in companies or for an innovation product; or conceptual maps/tables for theoretical categories of the project).

This study overall suggests that the students of the sample were exposed to writing experiences associated with the systems of values/ideologies of industrial engineering. The analysis of writer identities, textual arrangements, writing processes inferred from the samples, and the presence of visuals reveals that the assignments provided experiences for students to enact as practitioners and researchers to create audiences other than instructors (potential sponsors and consumers; company owners, directives or managers; and, other lab researchers). However, from freshman to senior assignments, a writer identity as a student in reporting to instructors is also always present. This study thus confirms a hybrid nature (academic and professional) of the assignments in engineering majors.

The analysis of the samples did not shed light on how the students defined the format of the assignments; an emerging hypothesis is that students might have followed a table of contents or a certain guideline suggested by the instructors. This idea might have to be confirmed through conducting further interviews with the students/writers of the writing samples.

D. Describing development of writing variation within a Colombian major in Industrial Engineering

Writing variation across curriculum

The analysis of the survey responses and the writing assignments of this study suggest that the writing experiences throughout the major embrace diverse functions, which are, according to the students' perspectives:

- Writing to learn;
- Writing to apply content knowledge;
- Writing to research;
- Writing to communicate ideas; and,
- Writing for senior thesis.

Additionally, writing assignments seem to trace diverse developmental paths identified by the researcher's analysis:

- Writing for innovation;
- Lab writing;
- Writing for company analysis; and,
- Writing for conducting a senior thesis.

This evidence confirms that curriculum experiences demand students to develop an ability to write differently while they learn how to satisfy writing demands across contexts that might be even contradictory or that cannot be overlapped (Beaufort, 1999; Carroll, 2002; Beaufort, 2007; Brent, 2012), which has been called the development of the "rhetorical survival instinct" (Brent, 2012).

There is a match between perspectives of the survey participants and the researcher's analysis regarding the role of writing within the major associated with conducting a senior thesis. This match suggests that this specific expectation is explicit in the curriculum and students' experiences reported in the survey seem to confirm that they have identified this learning goal within the program. Other writing functions identified by the survey participants seem to be more aligned to writing to learn and writing to apply content knowledge, which might suggest that writing is especially associated with assessment.

Furthermore, the analysis of the writing assignments suggests that despite there is a junior assignment titled: "Getting juice sweetened with buds and leaves of sugarcane" that positions students in their role of scientists (Lerner, 2009), it seems that this type of assignment is less frequent than innovation, improvements, and research proposals for company/business. This finding about the less frequent presence of writing assignments that demand a professional identification with scientific careers (Poe, Lerner & Craig, 2010) might suggest that this is not one of the strongest educational expectations within this major. This hypothesis can also be reinforced by the type of survey answers related to professional identification that the participants mentioned (i.e., this major fulfills my job market and professional aspirations: 51 cases, Industrial engineering is the most complete major in terms of the administrative knowledge: 19 cases; and, I wanted to learn about production process and how to conduct projects that improve companies' efficiency: 10 cases). Further data must be collected to confirm this hypothesis about the professional profile that seems to be valued within this major.

In terms of the writing assignments' length reported in the survey and the samples analyzed, this study suggests that there is no pattern across contexts. However, the average length of pages for assignments and the median suggest that students might have been mostly asked for writing documents between 26 and 46 pages. These numbers should be taken in consideration to anticipate that at the end of this major the students are expected to write a senior thesis report that likely implies writing more than such amounts of pages. Therefore, since a developmental point of view in which expertise is achieved cumulatively and progressively, pedagogic experiences should be envisioned to support students in handling these amount of pages and control/master writing demands accordingly.

Knowledge to repurpose: rhetorical abilities and rhetorical competence (writing theories of students across contexts)

The analysis of the writing samples in this study is an exploration of the rhetorical skills of the students: their ability manifested in the actual productions (Brent, 2012). Therefore, the following two hypotheses are emerging from the analysis of the textual arrangements, the writing processes, and the citation conventions: a) the students might have not had to decide how to organize the contents (since it seems that they had worked on a template that had been provided[51]); and, b) there is no pattern in citation conventions or systematic teaching on explicit intertextuality (to embed the own voice among others while avoiding plagiarism).

This ability to decide how to organize contents and articulate them (by taking in consideration practices of citation and explicit intertextuality) seems not to be part of the "rhetorical competence" developed by students (i.e., according to Brent (2012), which is the knowledge to encompass the sum of what the writer is in principle capable of doing). This conclusion is also supported by the types of answers offered by the survey participants when reporting about what they had learned from the writing experiences and types of advice they would offer to incoming students. Since these types of responses can count as what students recalled as they learned from the writing experiences, these answers overall suggest that the participants have developed as part of their theories/assumptions that writing is intertwined with reading, although their abilities to integrate and cite other sources seem not to be mastered according to the analysis of writing assignments.

Furthermore, the survey responses also suggest that in the major most of the experiences might have a lack of pedagogical support (writing is a solitary endeavor), since survey participants are advising that incoming students should already know how to write – preparedness- (e.g., advices such as: "developing good writing skills and reading comprehension": 12 cases; "investing time for independent study": 11 cases; "starting developing early the project": 5 cases). This assumption about "writing as a solitary endeavor" is reinforced by the results of the responses regarding to what extent the writing experiences reported by the students were similar to prior ones within and outside the major,

[51] This hypothesis might be confirmed through further conducting interviews with the students who provided the writing samples.

from which the tendency was that the writing experiences were perceived as “new writing situations”. If these perceptions are compared with the attempt to depict diverse writing paths that are rebuilt according to the analysis of the writing samples (figure 3), the evidence shows again that students of this major may likely not see connections among writing experiences, since the curriculum exigencies are in fact highly diverse across the curriculum years. Moreover, it seems that these students experience writing in isolated contexts (e.g., innovation projects only until sophomore years, lab reports of experiment only in junior years, company analysis from junior year forward) and not in a variety of contexts.

In addition, the analysis of the visuals across the writing samples suggests, for instance, that students are required to think of business plans constrained by time and resources (Lerner, 2009) during freshman and sophomore writing assignments related to designing innovation projects, and once again when writing senior thesis proposals in senior years (i.e., timelines were include only in a freshman titled “Project polymer (desk)”, and a senior assignment titled “Good practices of storage representations risk to be certified by Invima”). However, from a curriculum design that is development-oriented, these two types of financial and time constraints might be different for these three learning moments (freshman, sophomore, and senior), and genre practices (innovation projects and senior research proposals).

This lack of explicit teaching of genre variation might negatively affect people ability to extract the relevant features of the concepts and develop a more flexible representation of knowledge that can be used more generally (Bransford et al., 2000). Therefore, being exposed to such diverse writing experiences without educating students to explain and understand genre variation might become problematic if the expectation is that the students repurpose easily at the end of the program, all of the writing practices that might or not overlap in order to write a senior thesis for the very first time and probably for the only time in their academic trajectories. If this is the expectation, the literature review suggests that students' attempts to repurpose is more likely to be seen as “negative transfer”, since from the perspective of the faculty members and institutional assessment, instructors overlook attempts when students seem not to see the connections that faculty members expect (Nowacek, 2011; Moore, forthcoming).

Furthermore, the analysis of the survey responses suggests that part of the genre learning developed by the survey participants implies as generalization the idea that writing in the major is related to what they called “reports”. When the participants mentioned the name of the writing experiences, the label “report” was utilized to regard the type of writing they described; whereas, for the researcher, the analysis of the writing assignments revealed writing experiences that imply diverse types of genre activities that cannot be only encapsulated under the label “reports”, such as projects for innovations, reports of lab experiments, research proposals in companies, and company analysis reports. Such analysis of the writing samples provides nuances for this generalization (i.e., sense of shape, structure, rhetorical stance, and thinking strategies) (Reiff & Bawarshi, 2011), which were not evident in the types of survey responses of the participants. This finding suggests that what the students in this major are doing is a sort of application (Nowacek, 2011) by learning decontextualized “skills” (Wardle, 2009), since similarities and differences among writing experiences cannot be explained by them from specific and disciplinary writing theories.

This analysis ultimately confirms the risk of narrowing writing/rhetorical education into exposition and immersion (Beaufort, 1999) or, if provided, offered based on textual-linguistic orientation, since within this approach genres would be more likely to be depicted as individual entities encapsulated by labels as “reports”; instead, this study confirms that different types of problems (research in companies or creating new devices) can be treated through different types of genres (research proposals in companies and project of innovation), despite the same label (i.e., report) is being used to group such writing experiences.

Participation in communities of practice: legitimate peripheral participation and guided participation

The analysis of the writing assignments and the types of answers of the survey do not reveal to what extent writing experiences in this major are embedded in legitimate peripheral participation (Lave & Wenger, 1991). Although the analysis of voices/discursive identities of the writing assignments reveals multifaceted roles that must be enacted by students as writers (professional in innovation, company analyst, or lab researcher), there is no evidence to claim that these experiences demanded students' participation within communities of practice. In fact, Carroll (2002) has suggested that immersion experiences as internships seem to highly impact the way students recall their writing experiences. However, survey data about writing experiences reported by the participants suggest that students do not recall any particular experience that implied they interacted or communicated ideas to audiences other than instructors; nevertheless, the survey participants point out that the writing experiences reported embraced diverse functions[52] among which they mentioned "writing to communicate ideas to readers", who seem to be regarded as general audiences. This might suggest that a writing theory supporting this assumption of the survey participants is that writing implies externalizing the own thoughts but not necessarily by shaping such thoughts rhetorically (taking in account genre conventions, audiences, identities, purposes, writer roles and participation within and among communities of practices, personal motives, and agency).

The analysis of the writing assignments also suggests that although the writers/students are enacting diverse discursive identities (professional in innovation, company analyst, or lab researcher) to create textually audiences accordingly (sponsors, potential customers, company owners, or peers), the assignments have been simultaneously addressing their instructors. Therefore, these writing assignments might not support audience awareness development and improvements of textual performances accordingly (Rijlaarsdam, et al., 2009; Lerner, 2009), since the actual readers seem to be only the instructors and not be part of experiences comprised of an interdisciplinary team of readers (sponsors, industry professionals, senior peers, and instructors) (Swarts, & Odell, 2001; Lerner, 2009; Poe, Lerner, & Craig, 2010). This conclusion is also reinforced by the analysis of visuals that suggests that from freshman to senior years, visuals are primarily addressing the own thinking process of the writer, in this case an engineer analyzing a problem and making decisions accordingly, (e.g., the visual called "problem tree") or reporting/organizing information for instructors (conceptual maps).

The analysis of the types of problems associated with the assignments suggests that the students of this major are expected to write assignments within the system of values (ideologies) of the field by utilizing writing to solve problems such as:

a) Creating devices that expand functions of prior ones;

b) Complying with public policies/standards in companies;

c) Reducing time in production and commercialization;

d) Reutilizing leftovers of production process; and,

e) Identifying financial needs in companies.

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[52] i.e., Writing to learn; Writing to apply content knowledge; Writing to research; or, Writing to conduct a senior thesis.

These types of problems imply students need to think of business and company contexts. In fact, according to the analysis, some of the writing practices that might have been conducted to complete the assignments of the sample included:

- Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project.
- Copying institutional information of companies/organizations.
- Conducting fieldwork on companies/organizations.
- Identifying a problem (either in company production or a research problem to be addressed in a company production).
- Selecting companies/types of business to conduct a case study.

Contextualizing such writing assignments within types of business and companies is not enough evidence to assert that these experiences have been conducted as part of "legitimate peripheral participation". This study thus suggests according to the data collected from the students that within this major writing experiences tend to be inscribed in "guided participation" for learning content knowledge about the field and not necessarily about writing (facilitated performance in classrooms). In other words, students are using writing as means to learn about professional contents but not necessarily they are learning about writing theories to enhance writing awareness and performance.

Additionally, although the survey analysis shows that the participants seem to have developed a professional identification to the field[53], when they reported about their writing experiences specific disciplinary writing practices are not described; the participants only mentioned conducting a senior thesis as one of the functions of writing within the major, and also complying with citation standards of the Colombian norm called “ICONTEC”. This data might reinforce that this study does not report evidence of “legitimate peripheral participation” within engineering writing practices (Dias, & Paré, 2000; Rounsaville, 2012).

Implications

According to the survey participants’ profiles, the findings of this study can be primarily associated with the perspectives, experiences, or opinions of male junior undergraduates of a Colombian major in industrial engineering that have developed a professional affiliation to the field. Therefore, for these participants’ profile, the findings overall suggest that students of this major are not developing genre awareness (ability to identify and report genre features) (Artemeva, 2010), although they seem to be able to produce/mimic texts of diverse genres (Artemeva, 2010). One pedagogical opportunity that curriculum can offer to enhance the development of genre awareness (rhetorical competence) is to design interconnected course assignments (capstone projects achieved across sequences of courses) that might benefit knowledge recontextualization, if explicitly taught (Artemeva, 2005). However, what this study shows is that writing for accomplishing a senior thesis is not the only expectation across the writing experiences within the major; therefore, further studies and pedagogical debates with faculty members are necessary to define what writing developmental paths are expected from the students and how many curriculum projects (that include explicit teaching on theories of disciplinary writing and genre knowledge) across the curriculum should be undertaken.

[53] i.e., This major fulfills my job market and professional aspirations: 51 cases; Industrial engineering is the most complete major in terms of the administrative knowledge: 19 cases; and, I wanted to learn about production process and how to conduct projects that improve companies' efficiency: 10 cases.

E. Conclusions

This study aggregates data about accounts of writing development in a major of industrial engineering in a Colombian university. Accounts of writing variation development were created by curriculum years (freshman, sophomore, junior, and senior) through exploring retrospective accounts of writing experiences and analyzing writing assignments of undergraduate students.

The analyses of the survey responses and the writing assignments of this study suggest that the writing experiences throughout the major embrace diverse functions, which are, according to the students' perspectives: Writing to learn; Writing to apply content knowledge; Writing to research; Writing to communicate ideas; and, Writing for senior thesis. Additionally, writing assignments seem to trace diverse developmental paths identified by the researcher's analysis: Writing for innovation; Lab writing; Writing for company analysis; and, Writing for conducting a senior thesis.

The analysis of the writing assignments and the types of answers of the survey do not reveal to what extent writing experiences in this major are embedded in legitimate peripheral participation (Lave & Wenger, 1991). Although the analysis of voices/discursive identities of the writing assignments reveals multifaceted roles that must be enacted by students as writers (professional in innovation, company analyst, or lab researcher), there is no evidence to claim that these experiences demanded students' participation within communities of practice. Survey participants point out that the writing experiences reported embraced diverse functions among which they mentioned "writing to communicate ideas to readers", who seem to be regarded as general audiences. This might suggest that a writing theory supporting this assumption of the survey participants is that writing implies externalizing the own thoughts but not necessarily by shaping such thoughts rhetorically. The analysis of the writing assignments also suggests that although the writers/students are enacting diverse discursive identities to create textually audiences accordingly, the actual readers seem to be only the instructors; therefore, the writing assignments are not part of experiences comprised of an interdisciplinary team of readers (sponsors, industry professionals, senior peers, and instructors) (Swarts, & Odell, 2001; Lerner, 2009; Poe, Lerner, & Craig, 2010).

The analysis of the survey responses also suggests that part of the genre learning developed by the survey participants implies as generalization that writing is related to what they called "reports". This finding confirms the risk of narrowing writing/rhetorical education into exposition and immersion (Beaufort, 1999) or, if provided, offered primarily as a textual-linguistic orientation, since within this approach genres would be more likely to be depicted as individual entities encapsulated by labels as "reports". Instead, this study confirms that different types of problems (research in companies or creating new devices) can be treated through different types of genres (research proposals in companies and projects of innovation), despite the same label (i.e., report) is being used to group such writing experiences. In fact, the analysis of the writing samples provided nuances that seem not to be evident in the types of survey responses of the participants. Therefore, this study suggests that the students in this major are doing basically a sort of application (Nowacek, 2011) by learning decontextualized "skills" (Wardle, 2009), since similarities and differences among writing experiences cannot be explained by them from specific and disciplinary writing theories.

Furthermore, survey participants identified, as the analysis of the researcher confirmed, that one of the writing functions in the major is related to conducting a senior thesis. This suggests that such expectation is explicit in the curriculum and the students' experiences seem to confirm it; thus, they have identified this learning goal within the program. However, what this study shows is that writing for accomplishing a senior thesis is not the only expectation across the writing experiences within the major; therefore, further studies and pedagogical debates with faculty members are necessary to define what writing developmental paths are expected from the students and how many curriculum projects (that include explicit teaching on theories of disciplinary writing and genre knowledge) across the curriculum should be undertaken.

Any attempt of envisioning writing curriculum interventions under this condition of variation (Blake, 2015) (of genres, writer identities, writing processes, audiences, and so forth) must identify writing practices and values that might overlap and become contradictory to support students in seeing such similarities and differences as well. Moreover, any writing intervention must be also undertaken along with systematic longitudinal assessment aiming at defining what is more likely to be performed by the students over time and under the curriculum experiences they have been exposed.

Appendix 1
Survey protocol

Section	Questions	Justification
Introduction	Your participation is voluntary and your responses will not be released to your instructors; therefore, your grades for this class or your overall performance in this Program will not be affected. You have the right not to answer questions you think are asking personal issues.	
General information	18. Admission year 19. Gender (F/M) 20. Day student (Y/N) 21. Major name 22. Why are you studying this program? 23. Have you worked in a project/job related to engineering? (Y/N) 24. Are you working currently in a project/job related to engineering? (Y/N)	Factors that might impact how students describe their writing experiences (1-7)
Descriptions of writing experiences	Select an assignment or another project you have done in your program that was a writing experience. Describe the experience as follows:	
	13. Name of the writing assignment 14. Topic of the writing assignment 15. Number of pages 16. Name of the class 17. Semester and year	Situational factors associated with the writing experience (8-12)
	18. What is the relationship of the assignment with the class? 19. What was the instructor's goal? 20. What you learned from that experience? 21. What advice you would give to incoming students to face the same assignment?	Exploring how students make sense of the writing experience (question 13-14-15) What students can grasp/learn about the experience (questions 15-16)
	18. Select if the writing experience you described was positive _____ or negative ______ Justify your answer with at least 1 reason	Reasons to regard the writing experiences as positive in the program (question 17)
	19. Is this assignment similar to others you had done in other experiences <u>in the program</u>? Yes No If so, please provide the following information: Name of the experience: Topic: 20. Is this assignment similar to others you had done in other experiences <u>in the program</u>? Yes No If so, please provide the following information: Name of the experience: Topic:	Exploring knowledge that students can reutilize (retrospectively, laterally, and forward) in writing experiences (questions 18-19)
Further participation	If you decide to further participate voluntarily in this project, please provide your name, personal e-mail, and mobile. I will contact you to conduct interviews and ask you to provide writing samples of your assignments	

Appendix 2
Participants' recruitment

Name of the class	Semester	Curriculum year of the class	# of applied surveys	Day/Night
Research seminar	7 & 8	Junior/Senior	8	N
Occupational health	8 & 9	Senior	9	N
Occupational health	8 & 9	Senior	12	D
Research seminar	7 & 8	Junior/Senior	15	N
Conceptual Design	2 & 3	Freshman/Sophomore	19	D
Conceptual Design	2 & 3	Freshman/Sophomore	14	N
Conceptual Design	2 & 3	Freshman/Sophomore	25	D
Methods in engineering	5 & 6	Junior	18	D
Research seminar	7 & 8	Junior/Senior	16	D
Methods in engineering	5 & 6	Junior	16	N
Total			152	

Appendix 3

Triangulation t to articulate survey participants talked about the relationship among the writing assignments, the class and instructors' goals, and what they learned according to they mentioned explicitly as "learning"

Writing functions of the writing assignments	Categories for the responses		
	Relationship between the writing assignments and the class	Instructors' goal for assigning the writing assignments	What they learned
Writing to learn (thought development, organizing ideas)	• To support thought development (10 cases)		• Organizing ideas before writing (16 cases) • Coherence between writing and thought—developing ideas deductively from general to specific details (15 cases)
Writing to apply content knowledge (assessment)	• Applying content knowledge of the classes (19 cases) • Support learning on research and industrial issues (17 cases)	• Applying content knowledge of classes based on professional contexts (15 cases) • Preparing students for professional experiences (14 cases) • Assessment on class topics (11 cases)	• Writing about technical concepts (30 cases)
Writing to research		• Learning on research and analysis (10 cases)	• How to frame a project -- Ability and fluency for presenting projects (18 cases) • Research and structuring ideas (15 cases)
Writing to conduct a senior thesis		• Preparing students to conduct a senior thesis (19 cases)	• Complying with citation standards (Colombian norms: ICONTEC) • Framing problem statements, introductions, and conclusions (11 cases)
Writing to communicate ideas	• Writing was necessary to communicate ideas (18 cases) • Conclusions have to be clear for readers (15 cases)	• Developing skills to express ideas (49 cases)	

Appendix 4
General features of the writing assignment provided voluntarily by the survey participants

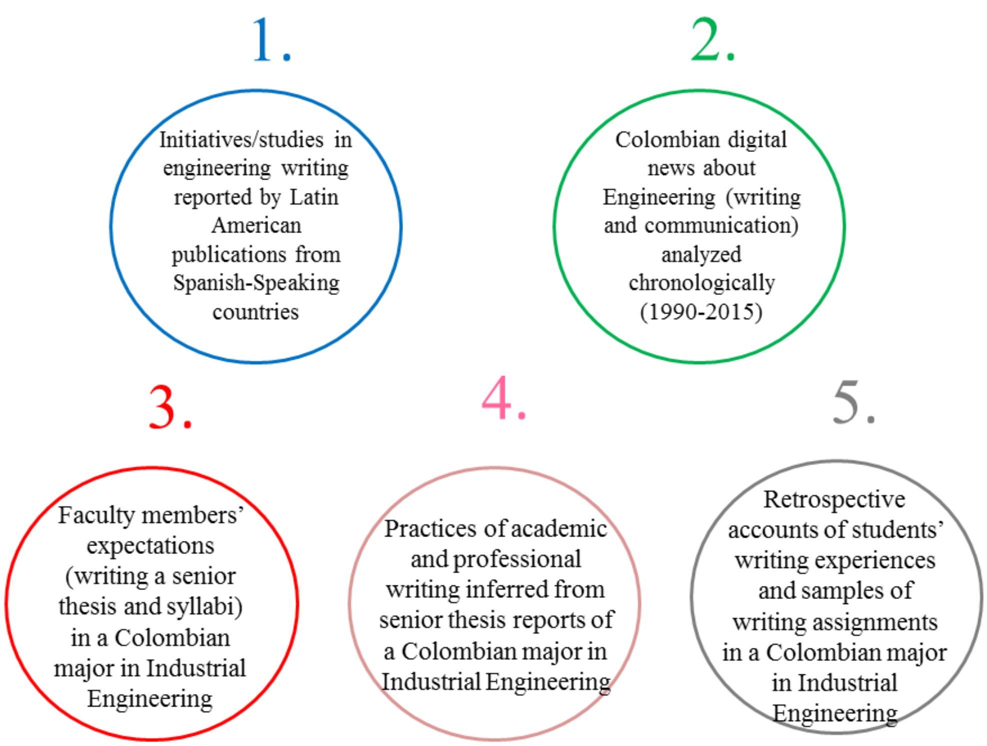
Gender	Daily or night student	Year admitted	freshman, sophomore, junior or senior	Assignment titles
M	D	2009	Senior	Good storage practices in “risk representations” to be certified by [name of a company]
M	D	2011	Junior	Device for impaired hearing children “permanent communication kids”
M	N	2011	Junior	Redesign of drying ovens in artisanal brick production
F	D	2013	Freshman	Final Draft introduction to Engineering 2
M	D	2010	Senior	Final project of Industrial Processes: Obtaining sugar juice from sugarcane leaves
M	N	2009	Senior	Final work (technological management)
M	N	2009	Senior	Research proposal for a research seminar
M	D	2011	Junior	Technological Plan for distillery “The Drunk”
F	D	2009	Senior	Loading device for motorcycles

Conclusions

Mapping expectations on writing and communication in engineering within a regional context: accounts from a Latin-American case

This dissertation describes local elements at stake in Latin America to define disciplinary writing and communication expectations of development in higher education as a phenomenon that goes well beyond freshman composition courses. Multiple sites of expectations of writing in engineering have been revealed through diverse data sources. Figure 1 is a depiction of these multiples sites:

Figure 1
Depiction of multiple sites from which data has been created



Ideally speaking, developmental expectations on writing and communication from these multiple sites should coincide perfectly to configure the "ideal and clear goal" of educating engineers as writers and communicators. Within this ideal scenario, expectations of writing development would be the same from all sources and all students should follow only one developmental path (i.e., either becoming writers of case studies to apply learning concepts, senior thesis, business proposals, or innovation projects); thus, assessing writing development could rely exclusively on one source of information, as happens when it is primarily informed by large-scale assessments or reports of senior thesis.

However, the analyses of this study offers evidence of more complex, multiple, and even conflicting expectations in answering the research question: *What might be the expectations on writing and communication in an engineering undergraduate program of a Latin-American university?* Namely, we find that:

1. *Expectations include both verbal and non-verbal components, which can be further categorized according to functions in education, academia, and the workplace*

The analysis of every source of expectations (mentioned in figure 1) can be grouped around two categories:

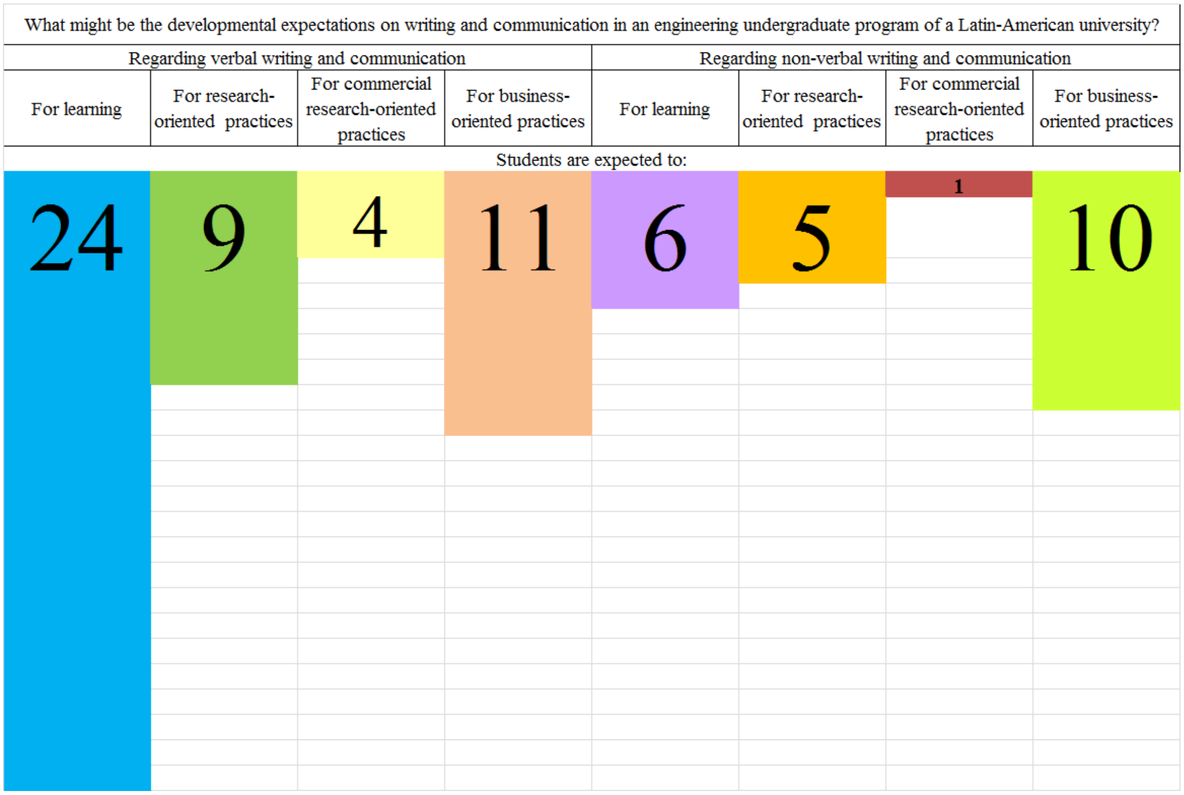
a. verbal writing and communication (e.g., students are expected to master professional genres in Spanish that will encounter in professional sites such as the Annual report and the standardized operating procedure); and,
b. non- verbal writing and communication (e.g., students are expected to articulate verbal and non-verbal systems such as tables and graphics to analyze problems in companies).

Within these two groups, these expectations can be also categorized in four groups:

1. Expectations for learning (e.g., students are expected to write in Spanish to think and to learn disciplinary concepts across curriculum by writing assignments such as weekly reports, metacognitive writing to solve mathematical problems, and summaries of readings).
2. Expectations for research-oriented practices (e.g., students are expected to master English or other foreign languages for participating in research and technological innovations).
3. Expectations for commercial research-oriented practices (e.g., students are expected to conduct and write research projects for innovation).
4. Expectations for business-oriented practices (e.g., students are expected to identify and praise a writing system valuing standards and formats).

Appendix 1 presents a table with all of these expectations organized under the prior categories. If the expectations presented in appendix 1 are summed to identify the total amount of the categories from 1 to 4, the analysis shows that, as depicted in figure 2, the expectations are concentrated under the category: verbal writing and communication for learning (24 occurrences highlighted in blue and 6 occurrences highlighted in purple). Next most common are expectations of verbal and non-verbal writing and communication for business-oriented practices (11 occurrences highlighted in nude and 10 occurrences highlighted in light green).

Figure 2
Types and presence of expectations emerging from the analysis



This suggests that, in the data of this study, expectations of writing development in engineering value the most the role of writing to learn; for instance, students are expected to:

- Write in Spanish to think and to learn disciplinary concepts across curriculum by writing assignments (e.g., weekly reports, metacognitive writing to solve mathematical problems, and summaries of readings); and,
- Use writing to apply content knowledge by writing reports for cases studies and a senior thesis.

The classification of expectations related to verbal and non-verbal writing to learn reveals in turn three types of expectations (appendix 2):

a) Related to professional/disciplinary knowledge application and assessment. For instance, students are expected to design and use visuals to report/organize theoretical information for instructors (conceptual maps).

b) Related to learning in higher education. For instance, students are expected to develop learning abilities, including writing as such, to pursue and complete engineering majors, especially in the case they are non-traditional students (students from disadvantaged sectors of the population and women).

c) Related to specialized knowledge of writing, language, and communication. For instance, students are expected to master an engineering protocol for writing projects as classroom activity.

This classification ultimately provides insights to define content knowledge that must be taught explicitly to provide students with systematic writing education (either by writing courses or team teaching in disciplinary courses). If these types of expectations derived from the data of this study are stated as specific writing and communication knowledge that must be taught, the following contents are examples of teaching contents for engineers:

- What is a report?
- What is the difference between a weekly report to solve problems, a lab report, and a senior thesis report?
- Why there is variation in using writing and communication in engineering?
- What is an engineering protocol for innovation projects?
- What is intertextuality?
- How does intertextuality vary according to types of reports?
- What types of visuals are expected according to types of reports?

- What is voice and identity in writing?
- What types of voices and identities can be enacted in diverse types of engineering reports and why?
- How visual design and verbal content interact in a report?
- What is the difference between using visual to organize the own thinking and to analyze problems in companies?

2. *Expectations rely on conflicting systems of values*

This analysis of types of writing expectations for learning and becoming a practitioner in an engineering subfield also confirms that there are expectations relying on conflicting assumptions that become contradictory for the students, faculty members, or university directives.

One the one hand, one system values uniformity and non-variation in writing and communication, since writing is regarded as a general ability; for instance, students are expected to:

- Perform "good writing" in assignments by deploying conceptual clarity and coherence among paragraphs.
- Know that writing in general implies reading, intertextuality, and citation practices.
- Learn about interactions between visual and verbal design regardless genre practices.
- Write reports as a generic skill.
- See writing as a solitary endeavor and a general competence; regardless of genre practices, it is expected to conduct library search and close readings, contrast authors and perspectives, master time management for writing, handle a writing schedule, and carry out drafts and editing.

And, on the other hand, another system values alternative which in turn may conflict with each other when students are: 1) writing for learning; 2) writing for academic/research-oriented practices; or, 3) writing for workplace/business-oriented practices; for instance, students are expected to:

- Conduct and write reports for senior thesis as a requirement for degree completion versus write reports for case studies of company analysis.
- Articulate verbal and non-verbal systems to analyze problems in companies (problem three or fishbone diagram) versus design and use visuals to report/organize theoretical information for instructors (conceptual maps).
- Enact multifaceted voices/identities as writers (professional in innovation, company analyst, or lab researcher) to create textually audiences accordingly (sponsors, potential customers, company owners, or peers), while at the same time are reporting learning knowledge to instructors.

3. *Multiple sites of expectations create diverse interactions that shape multifaceted paths for writing development and communication*

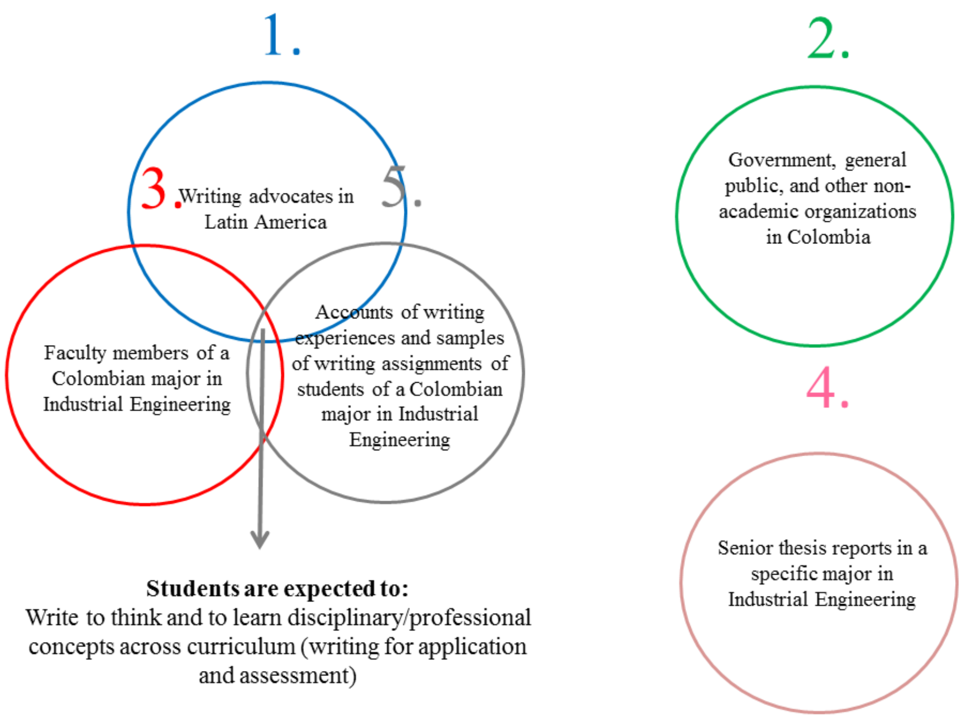
If the expectations of the five research sites revealed by the analysis of this study are contrasted to identify their intersections, then varying intersections are found. These intersections combine the interests of some groups and activities but not others. Therefore, developmental writing expectations do not interact evenly and there is no perfect intersection among them to configure the "ideal and clear goal" of educating engineers as writers and communicators.

The total of intersections of the expectations derived from the multiple sites revealed by this study is summarized in appendix 4. Here are some examples of such intersections, which are further illustrated in figures 3, 4, 5, and 6:

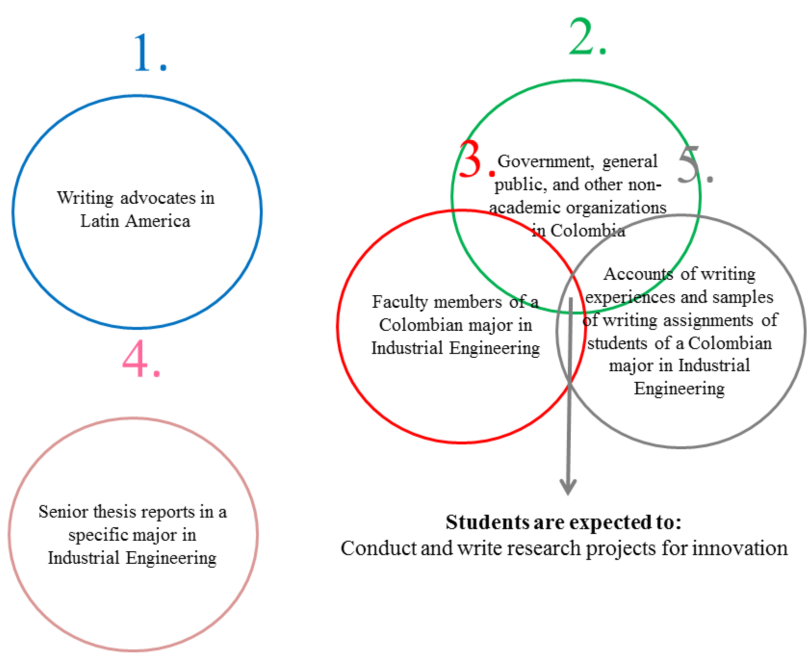
- Example 1: writing advocates, faculty and students of a major in Industrial engineering coincide in expecting that students use writing to learn disciplinary and professional concepts.
- Example 2: the government, general public, and other non-academic organizations agree with faculty and writing experiences of students in a major of Industrial engineering about the importance of conducting and writing research projects for innovation.
- Example 3: the government, general public, and other non-academic organizations agree with faculty and students of Industrial engineering that a senior thesis should be a requirement of degree completion.
- Example 4: Within an Industrial Engineering major, students are expected to articulate verbal and non-verbal systems (i.e., tables and graphics) to depict information of business and industrial processes (depicting companies graphically and holistically).

Therefore, writing development is not informed by the agreement among all of the sources, nor the expectations are configuring only one developmental path (i.e., either becoming writers of case studies to apply learning concepts, senior thesis, business proposals, or innovation projects); thus, assessing writing development cannot rely exclusively on one source of information.

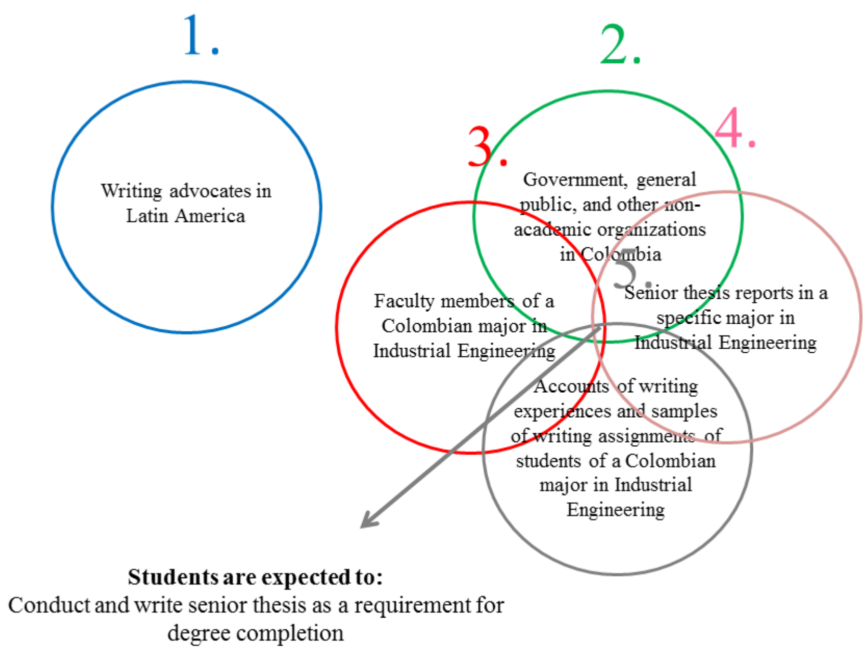
Example 1



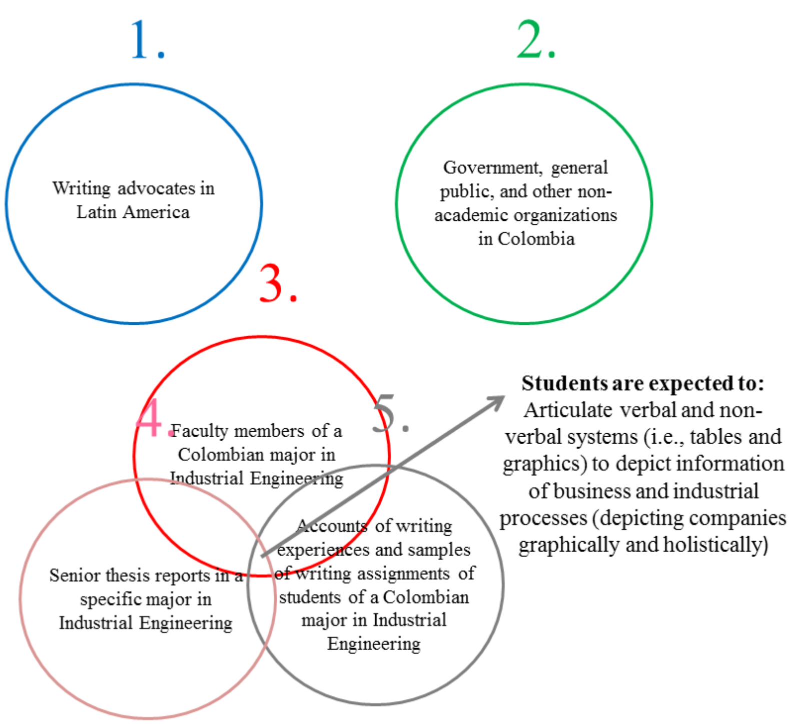
Example 2



Example 3



Example 4



Overall this study offers insights for the following four questions pertaining to the field of Writing Studies:

a. *What counts as "development of writing and communication" in a specific area of engineering: a Colombian major in industrial engineering?*

There are specific expectations associated with the field of industrial engineering in a developing economy that did not emerge when studies or initiatives regard “engineering” as one field without contextual nuances; for instance, this study shows that within a Colombian major in industrial engineering students are expected to:

- Propose and redesign new routines and cycles that will be standardized and mediated by guidelines of procedures that, in turn, are created by collecting data through tables, graphics, and matrices.
- Conduct and report company analysis to improve business practices based on national and international standards, which increases profitability and productivity in organizations.

These writing and communication expectations could be critically discussed with practitioners and faculty members of the field, since they could impact negatively the development of agency, empowerment, and critical stances of students and further practitioners. The analysis reveals that students use primarily writing and communication to “accept national and international standards to be implemented in local contexts (small companies of a developing economy) without critical stances”.

One of the hypothesis emerging from this study is that the size and ideological localization of the companies that are likely the contexts of professional practices of the practitioners of the field (i.e., small local business of a developing economy in the South that are striving to comply with international and national standards), might impact a) the degree of complexity of the communication practices to negotiate solutions and circulate, create, and accept genres (small companies, few stakeholders involved, less negotiation to create and accept genres and standards , which might generate more vertical and hierarchical communication), and b) the opportunity for engineering students to develop critical stances about improving entrepreneurial environments, since they might be more concerned in genre consumption and production (such as regulations and guidelines) to regulate practices under external powerful standards (which might be primarily mandated by developed economies). Therefore, it might be interesting to conduct further comparative studies on exploring genre productions and consumptions of "guidelines" in educating industrial engineers of developed and developing economies.

Furthermore, this study confirms that within the Engineering field in general, and in Industrial Engineering in particular, writing and communication rely on verbal and non-verbal practices that embrace different functions, which in turn imply several developmental paths that might or not might overlap, such as:

a) Writing for learning disciplinary and professional concepts
b) Writing for research-oriented practices
c) Writing for commercial research-oriented practices
d) Writing for business-oriented practices
e) Writing for conducting and accomplishing a senior thesis

Accordingly, if it is expected that students repurpose knowledge from all of these writing functions in a senior thesis, for the first time and probably for the only time in their academic trajectories, many contradictions emerge for them and faculty mentors in trying to define the hybrid nature of a senior thesis, since it is regarded as an evidence of academic and professional growth. Therefore, further pedagogical debates must be undertaken to define how to solve this conflict aiming to benefit learning opportunities for students and diminish pedagogical burden for faculty mentors.

Thus far, data produced by this dissertation allow claiming that conducting and writing a senior thesis in this major may become a writing endeavor comprised of two different writing practices that account for academic and professional growth of students while they address different audiences. In other words, a senior thesis in this field and major might include: a) one report addressing faculty members by reporting academic writing practices associated with data creation and analysis (this report should include traditional sections of academic projects such as introduction, problem statement, justification, literature review, theoretical frameworks, methodology, results, analysis, and conclusions); and, b) another report comprised of small reports to be presented ideally in meetings to owners, managers, plant managers, head of sales, workers, and/or operators in the company/organizations.

This distinction in creating and reporting knowledge might be useful in, one the one hand, helping students to deal with differentiating academic writing practices from professional writing practices while they have opportunities to increase their audience awareness, and, in the other hand, allowing faculty members to assess different paths of writing development: academic writing practices to accomplish a senior thesis, and professional writing practices to participate as engineers in companies/organizations.

b. *What does this study inform to Latin-American writing curriculum and teaching initiatives in engineering?*

Some sites of expectations revealed in this study suggest conventionality rather than variation and innovation for writing and communication practices (i.e., expectations related to the systems of values in which there is no variation are highlighted in yellow in appendix 3); however, the analysis reveals that variation is indeed part of becoming a writer and communicator in engineering in general and in industrial engineering in particular. For instance, for faculty members in a Colombian major, students are expected to: 1) Write reports for either, case studies, senior thesis, and lab reports; 2) Articulate verbal and non-verbal systems (i.e., tables and graphics) to either make decisions in companies (using graphic strategies to represent solutions of problems); or, depict information of business and industrial processes (depicting companies graphically and holistically); and, 3) Develop ownership and authorship through displaying a personal voice respectfully among others' vantage point; or by creating a personal voice and critical stance based on theoretical concepts.

Furthermore, from the perspective and experiences of students of the very same major, the analysis shows that they are expected to: 1) Write projects constrained by time and funding for Innovation projects and Senior thesis proposals; 2) Know that writing implies reading, intertextuality, and citation practices when conducting library search and close readings, contrasting authors and perspectives, and reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project; and, 3) Enact multifaceted voices/identities as writers (professional in innovation, company analyst, or lab researcher) to create textually audiences accordingly (sponsors, potential customers, company owners, or peers).

Additionally, the analysis of intersections among sites of expectations reveals that there are specific expectations emerging from the online news, which might represent the voice of the Government, general public, and other non-academic organizations in Colombia that are not present as expectations or curriculum endeavors of the other research sites revealed in this study. For instance, the voices of the Government, general public, and other non-academic organizations revealed by the analysis of online news suggest that they are expecting that students and practitioners: a) mastering English or other foreign languages for intercultural communication and business; b) writing to get graduate opportunities overseas; c) writing to get internship opportunities in multinationals; c) pursuing and completing engineering majors if they are non-traditional students (students from disadvantaged sectors of the population and women).

Therefore, Latin-American writing specialists and engineering faculty should discuss particularly how and when variations in teaching writing and communication should be incorporated in writing curriculum.

c. *What does this study from a developmental perspective contribute to genre studies in disciplines?*

This study confirms the risks of not offering writing/rhetorical education across curriculum, or if provided, offered only based on textual linguistic orientation, since within this approach genres would be more likely to be regarded as individual entities encapsulated by labels as "reports". Instead, this study confirms that different types of problems (research in companies or creating new devices) can be treated through different types of genres (such as research proposals in companies versus innovative project proposals), despite the same label (i.e., report) is being used to group such diverse writing experiences.

Therefore, this project confirms that understanding genres as part of systems of activity[54] (i.e., genre repertoires and genre systems) implies rethinking curriculum initiatives and studies under the assumption that students as further practitioners of their disciplines will be exposed to a spectrum of roles as genres users (either as readers or writers) and as part of complex overlapping activities impacted by issues of hierarchy and power within organizations.

d. *What does this study inform about teaching and assessing writing from a developmental point of view?*

Finally, this study confirms that there is no way to assess writing development in higher education through only one source of data, since there are diverse paths configured for all of the stakeholders involved (government, writing specialists, faculty members of disciplines, students, and practitioners of the fields): *development is multifaceted*.

Therefore, it is necessary that institutions, especially academic units in charge of writing education and research, define assessment programs to track and inform writing development in disciplines. Since there are so many expectations and demands that might or not might overlap, these expectations cannot be overloaded or packed within all of the courses. Therefore, curricula in general and writing curricula in particular must be designed under ongoing negotiations among stakeholders to define: a) the scope and limitations of the

[54] Theoretical category to explain social activity and its organization/reproduction by making visible the overlap and natural contradictions emerging from the interaction between a) social goals of communities/groups and personal motives of individuals within and across organizations/communities/groups, with b) division of labor, social roles, hierarchies and power, systems of values, status quo vs. innovation, and access/creation of artifacts (either material or symbolic).

interventions; and, b) the types of variations and systematic exigencies that will differ across time and contexts while they are simultaneously assessed and studied comprehensively and ecologically.

Appendix 1

Types of expectations on verbal and non-verbal writing and communication for learning organized by sites

Sites of expectations	**What might be the developmental expectations on writing and communication in an engineering undergraduate program of a Latin-American university?**							
	Regarding verbal writing and communication				**Regarding non-verbal writing and communication**			
	For learning	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**	**For learning**	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**
	Students are expected to:							
Writing advocates in Latin America	1.Write in Spanish to think and to learn disciplinary concepts across curriculum by writing assignments (e.g., weekly reports, metacognitive writing to solve mathematical problems, and summaries)			1.Master professional genres in Spanish that will encounter in professional sites (e.g., Annual report and standardized operating procedure)				

Sites of expectations	What might be the developmental expectations on writing and communication in an engineering undergraduate program of a Latin-American university?							
	Regarding verbal writing and communication				**Regarding non-verbal writing and communication**			
	For learning	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**	**For learning**	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**
	Students are expected to:							
Government, general public, and other non-academic organizations in Colombia	2.Master English or other foreign languages for degree completion	1.Master English or other foreign languages for research and technological innovations	1.Conduct and write research projects for innovation	2.Master English or other foreign languages for intercultural communication and business	1.Learn about interactions between visual and verbal design			
	3.Conduct and write senior thesis as a requirement for degree completion	2.Master writing practices of research-oriented institutions		3.Master writing practices of business-oriented institutions				
	4.Pursue and complete engineering majors if they are non-traditional students (students from disadvantaged sectors of the population and women)	3.Write to get graduate opportunities overseas		4,Write to get internship opportunities in multinationals				

Sites of expectations	What might be the developmental expectations on writing and communication in an engineering undergraduate program of a Latin-American university?							
	Regarding verbal writing and communication				**Regarding non-verbal writing and communication**			
	For learning	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**	**For learning**	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**
	Students are expected to:							
Faculty members of a Colombian major in Industrial Engineering	5.Write reports for cases studies and for a senior thesis	4.Write reports for labs		5.Identify and praise a writing system valuing standards and formats	2.Articulate verbal and non-verbal systems (i.e., tables and graphics) to analyze problems in companies	1.Depict data collected from labs to interpret results	1.Create data by measurements and reports across curriculum	1.Articulate verbal and non-verbal systems (i.e., tables and graphics) to make decisions in companies (using graphic strategies to represent solutions of problems)
	6.Master an engineering protocol for projects	5.Master an engineering protocol for projects	2.Master an engineering protocol for projects	6.Create standards and guidelines				2.Articulate verbal and non-verbal systems (i.e., tables and graphics) to depict information of business and industrial processes (depicting companies graphically and holistically)
	7.Perform good writing in assignments by deploying conceptual clarity and coherence among paragraphs							3.Interpret symbols in floor plans and diagrams
	8.Identify and praise a writing system valuing meaning negotiations				3.Create data by measurements and reports across curriculum	2.Create data by measurements and reports across curriculum		4.Create data by measurements and reports across curriculum
	9.Deal with intensive writing experiences at the extreme of							

	the major (freshman and senior years) that imply: “Addressing writing as a process”, “Writing implies prior reading and intertextuality”, and “Reading bibliographic resources carefully”.							
	10.Write a senior thesis proposal and its report							
	11.Write a senior thesis as a process bounded by timelines, deadlines, and budgets							
	12.Develop ownership and authorship in freshman year (“Writing for developing a personal voice respectfully among others' vantage point”)							
	13.Develop ownership and authorship in a senior year (“a personal voice and critical stance based on theoretical concepts”							
	14.Develop ownership and authorship in a senior year: “a personal voice embedded among others while avoiding plagiarism”.							

Sites of expectations	What might be the developmental expectations on writing and communication in an engineering undergraduate program of a Latin-American university?							
	Regarding verbal writing and communication				**Regarding non-verbal writing and communication**			
	For learning	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**	**For learning**	**For research-oriented practices**	**For commercial research-oriented practices**	**For business-oriented practices**
	Students are expected to:							
Senior thesis reports in a specific major in Industrial Engineering	15.Make a case by writing a senior thesis as an academic genre	6.Produce professional genres and artifacts related to learning processes in the field		7.Produce professional genres and artifacts related to engineering problems for company situations	4.Use visual diagrams to create hierarchies of conceptual categories	3.Produce professional genres and artifacts related to learning processes in the field		5.Produce professional genres and artifacts related to engineering problems for company situations
	16.Create literature reviews for a senior thesis			8.Propose and redesign new routines and cycles that will be standardized and mediated by guidelines of procedures		4.Design graphics to summarize survey results		6.Propose and redesign new routines and cycles that will be mediated by tables, graphics, and matrices
				9.Accept national and international standards to be implemented in local contexts (small companies) without critical stances		5. Collect data from other stakeholders in the company/business (tables and forms filled out by them) issue and by complying national and international standards related to company/institution situations		7.Articulate verbal and non-verbal systems (i.e., tables and graphics) to depict information of business and industrial processes (depicting companies graphically and holistically)
								8.Create pictures and drawings to analyze and compare the best practices against standards

								9.How to depict and describe routines and cycles of company situations
								10.Create “tables” to summarize drawbacks of company situations

Sites of expectations	What might be the developmental expectations on writing and communication in an engineering undergraduate program of a Latin-American university?							
	Regarding verbal writing and communication				Regarding non-verbal writing and communication			
	For learning	For research-oriented practices	For commercial research-oriented practices	For business-oriented practices	For learning	For research-oriented practices	For commercial research-oriented practices	For business-oriented practices
	Students are expected to:							
Accounts of writing experiences and samples of writing assignments of students of a Colombian major in Industrial Engineering	17.Use writing to learn	7.Use writing to research in senior years for senior thesis constrained by time and resources	3.Use writing in freshman and sophomore years for innovation by creating projects constrained by time and resources	10.Use writing form company analysis	5.Design and use visuals to organize the own thinking process and make decisions (e.g., the visual called “problem tree”)			
	18.Use writing to apply content knowledge	8.Use writing for lab reports			6.Design and use visuals to report/organize information for instructors (conceptual maps)			
	19.Use writing for completing a senior thesis							
	20.Write reports as a generic skill							

	21.Know that writing implies reading, intertextuality, and citation practices (i.e., conducting library search and close readings, contrasting authors and perspectives)	9.Know that writing implies reading, intertextuality, and citation practices (i.e., conducting library search and close readings, contrasting authors and perspectives)	4.Know that writing implies reading, intertextuality, and citation practices (i.e., Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project)	11.Know that writing implies reading, intertextuality, and citation practices (i.e., Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project)				
	22.Know that writing implies time management (writing schedule to developing drafts and editing)							
	23.See writing as a solitary endeavor and a general competence (writing without genre variation)							
	24.Use different types of genres (research proposals in companies and project of innovation) to treat diverse types of problems (research in companies or							

	creating new devices)							
	26.Enact multifaceted voices/identities as writers (professional in innovation, company analyst, or lab researcher) to create textually audiences accordingly (sponsors, potential customers, company owners, or peers), regardless having actual participations in communities of practices or interacting with readers/audiences other than their instructors							

Appendix 2

Types of expectations of verbal and non-verbal writing and communication for learning

Regarding verbal writing and communication			Regarding non-verbal writing and communication		
Related to professional/disciplinary knowledge application and assessment	**Related to specialized knowledge of writing, language, and communication**	**Related to learning in higher education**	**Related to professional/disciplinary knowledge application and assessment**	**Related to specialized knowledge of writing, language, and communication**	**Related to learning in higher education**
Write in Spanish to think and to learn disciplinary concepts across curriculum by writing assignments (e.g., weekly reports, metacognitive writing to solve mathematical problems, and summaries)	Master English or other foreign languages for degree completion	Pursue and complete engineering majors if they are non-traditional students (students from disadvantaged sectors of the population and women)	Create data by measurements and reports across curriculum	Learn about interactions between visual and verbal design	Use visual diagrams to create hierarchies of conceptual categories
Use writing to learn			Design and use visuals to organize the own thinking process and make decisions (e.g., the visual called "problem tree")	Articulate verbal and non-verbal systems (i.e., tables and graphics) to analyze problems in companies	Design and use visuals to report/organize information for instructors (conceptual maps)
Use writing to apply content knowledge	Conduct and write senior thesis as a requirement for degree completion				
Use writing for completing a senior thesis	Write reports for cases studies and for a senior thesis				
	Master an engineering protocol for projects				
	Perform "good writing" in assignments by deploying conceptual clarity and coherence among paragraphs				
	Identify and praise a writing system valuing meaning negotiations				

	Deal with intensive writing experiences at the extreme of the major (freshman and senior years) that imply: “Addressing writing as a process”, “Writing implies prior reading and intertextuality”, and “Reading bibliographic resources carefully”.	
	Write a senior thesis proposal and its report	
	Write a senior thesis as a process bounded by timelines, deadlines, and budgets	
	Develop ownership and authorship in freshman year (“Writing for developing a personal voice respectfully among others' vantage point”)	
	Develop ownership and authorship in a senior year (“a personal voice and critical stance based on theoretical concepts”	
	Develop ownership and authorship in a senior year: “a personal voice embedded among others while avoiding plagiarism”.	
	Make a case by writing a senior thesis as an academic genre	
	Create literature reviews for a senior thesis	
	Write reports as a generic skill	

	Know that writing implies reading, intertextuality, and citation practices (i.e., conducting library search and close readings, contrasting authors and perspectives)		
	Know that writing implies time management (writing schedule to developing drafts and editing)		
	See writing as a solitary endeavor and a general competence (writing without genre variation)		
	Use different types of genres (research proposals in companies and project of innovation) to treat diverse types of problems (research in companies or creating new devices)		
	Enact multifaceted voices/identities as writers (professional in innovation, company analyst, or lab researcher) to create textually audiences accordingly (sponsors, potential customers, company owners, or peers), regardless having actual participations in communities of practices or interacting with readers/audiences other than their instructors		

Appendix 3

Description of the two conflicting systems of values related to writing and communication for learning

System of values 1		System of values 2				
There is no variation in writing and communication		**There is variation in writing and communication**				
Verbal practices	**Non-verbal practices**	**Verbal practices**			**Non-verbal practices**	
Write in Spanish to think and to learn disciplinary concepts across curriculum by writing assignments (e.g., weekly reports, metacognitive writing to solve mathematical problems, and summaries)		Conduct and write senior thesis as a requirement for degree completion	Write reports for cases studies		Design and use visuals to organize the own thinking process and make decisions (e.g., the visual called "problem tree")	Design and use visuals to report/organize information for instructors (conceptual maps)
Perform good writing in assignments by deploying conceptual clarity and coherence among paragraphs	Learn about interactions between visual and verbal design				Articulate verbal and non-verbal systems (i.e., tables and graphics) to analyze problems in companies	
Identify and praise a writing system valuing meaning negotiations					Create data by measurements and reports across curriculum	
Know that writing implies time management (writing schedule to developing drafts and editing)		Write a senior thesis as a process bounded by timelines, deadlines, and budgets	Make a case by writing a senior thesis as an academic genre			
Know that writing implies reading, intertextuality, and citation practices (i.e., conducting library search and close readings, contrasting authors and perspectives)		Create literature reviews for a senior thesis	Know that writing implies reading, intertextuality, and citation practices (i.e., Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project)			

Deal with intensive writing experiences at the extreme of the major (freshman and senior years) that imply: “Addressing writing as a process”, “Writing implies prior reading and intertextuality”, and “Reading bibliographic resources carefully”		Develop ownership and authorship in freshman year (“Writing for developing a personal voice respectfully among others' vantage point”)	Develop ownership and authorship in a senior year (“a personal voice and critical stance based on theoretical concepts”	Develop ownership and authorship in a senior year: “a personal voice embedded among others while avoiding plagiarism”.		
See writing as a solitary endeavor and a general competence (writing without genre variation)	Write reports as a generic skill	Use different types of genres (research proposals in companies and project of innovation) to treat diverse types of problems (research in companies or creating new devices)	Enact multifaceted voices/identities as writers (professional in innovation, company analyst, or lab researcher) to create textually audiences accordingly (sponsors, potential customers, company owners, or peers), regardless having actual participations in communities of practices or interacting with readers/audiences other than their instructors			

Appendix 4
Intersections of expectations of verbal and non-verbal writing and communication among research sites

	Sites of expectations				
	Writing advocates in Latin America	Government, general public, and other non-academic organizations in Colombia	Faculty members of a Colombian major in Industrial Engineering	Senior thesis reports in a specific major in Industrial Engineering	Accounts of writing experiences and samples of writing assignments of students of a Colombian major in Industrial Engineering
Expectations of verbal writing and communication Students should be able to:					
1. Write to think and to learn disciplinary/professional concepts across curriculum (writing for application and assessment)					
2. Conduct and write research projects for innovation					
3. Conduct and write senior thesis as a requirement for degree completion					
4. Master writing practices of business-oriented institutions					
5. Know that writing implies reading, intertextuality, and citation practices while ownership and authorship are developed: a) conducting library search and close readings, contrasting authors and perspectives; b) Reading and summarizing information from other sources to describe materials needed in companies/organizations, or situations related to the project; c) Writing for developing a personal voice respectfully among others' vantage point; d) a personal voice and critical stance based on theoretical concepts; and, e) a personal voice embedded among others while avoiding plagiarism					
6. Know that writing implies time management (writing schedule to developing drafts and editing)					

7. Use different types of genres (research proposals in companies and project of innovation) to treat diverse types of problems (research in companies or creating new devices)

8. Create standards and guidelines

9. Identify and praise a writing system valuing standards and formats

10. Propose and redesign new routines and cycles that will be standardized and mediated by guidelines of procedures

Expectations of non-verbal writing and communication
Students should be able to:

1. Articulate verbal and non-verbal systems (i.e., tables and graphics) to depict information of business and industrial processes (depicting companies graphically and holistically)

2. Articulate verbal and non-verbal systems (i.e., tables and graphics) to make decisions in companies (using graphic strategies to represent solutions of problems)

3. Propose and redesign new routines and cycles that will be mediated by tables, graphics, and matrices

4. Depict and describe routines and cycles of company situations

5. Design and use visuals to organize the own thinking process and make decisions (e.g., the visual called "problem tree")

6. Design and use visuals to report/organize information for instructors (conceptual maps)

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